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Holocene benthic foraminiferal and ostracod assemblages in a paleo-hydrothermal vent system of Campi Flegrei (Campania, South Italy)

Giuseppe Aiello, Diana Barra, Roberta Parisi, Roberto Isaia, and Aldo Marturano

ABSTRACT

The succession of the Late Quaternary La Starza terrace, located within the Campi Flegrei caldera, on the Tyrrhenian side of southern Italy, represents a well-known example of deposition under the combined influence of bathymetric and physico-chemical variations due to volcanic activities. One hundred and seven samples collected in six outcrops and some tunnel excavation fronts, with an age between ~12 and ~4 k.y.a, comprise both barren and fossiliferous sediments. The latter contain siliceous and/or calcareous microfossil remains, including benthic foraminiferal and ostracod assemblages indicative of a marine paleodepth ranging from the upper infralittoral to the upper circalittoral zone, with phases of intense environmental stress typical of a hydrothermal system. A detailed reconstruction of the Holocene paleoenvironmental evolution of the succession is presented. The majority of foraminiferal and ostracod species is illustrated and brief taxonomic and ecological notes are given for each of them.

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INTRODUCTION

The occurrence of well-developed sedimentary sequences yielding calcareous fossil remains in volcanic areas may provide a useful tool for evaluating the relationship among ground deformations, volcanic activities and paleoenvironmental evolution. In the late Quaternary succession of the La Starza terrace at the Campi Flegrei caldera, located on the Tyrrhenian side of southern Italy, abundant meiofaunal remains have been found, with the notable presence of relatively well-preserved benthic foraminiferal tests and ostracod shells. As the ecological characteristics of the Quaternary species are generally well known, we undertook a detailed micropaleontological survey to determine the faunal content of the deposits and to establish the environmental changes occurred during the Holocene in this sector of the Phlegrean Fields. Benthic foraminifers (protists) and ostracods (crustaceans) show different sensitivity to ecological parameters such as water depth, salinity, saturation in $CaCO_3$, dissolved oxygen, type of bottom sediment and consequently the coupled analyses of the two taxa can be used to improve the detail and accuracy of the paleoenvironment model.

GEOLOGICAL SETTING

The La Starza marine terrace is one of the major structures within the Campi Flegrei caldera (Figure 1), an active volcanic area resulted from two main late Pleistocene events, the Campanian Ignimbrite super eruption (~40 k.y.a) (De Vivo et al., 2001; Giaccio et al., 2008; Costa et al., 2012) and the Neapolitan Yellow Tuff eruption (~15 k.y.a) (Orsi et al., 1992; Scarpati et al., 1993; Deino et al., 2004). Some marine ingressions formed the terrace that ends on the coastward side with a fossil marine cliff where interlayered tephra and Holocene marine sediments outcrop. The depositional history of the La Starza terrace has been influenced by the ground deformations linked with the eruptive events, by slow bradyseismic movements and by the sea-level variations occurred in the Mediterranean during the late Quaternary (Cinque et al., 1985; Orsi et al., 1996; Di Vito et al., 1999; Bellucci et al., 2006; Isaia et al., 2009; 2016; Lambeck et al., 2011; Marturano et al., 2018). The succession reflects deposition during three main phases of intense volcanic activity, ranging in the intervals of 15.0–10.6 k.y.a (Epoch I), 9.6–9.2 k.y.a (Epoch II) and 5.5–3.5 k.y.a (Epoch III), respectively (Di Vito et al., 1999; Smith et al., 2011; Isaia et al., 2015) and two rest periods (Figure 2). The

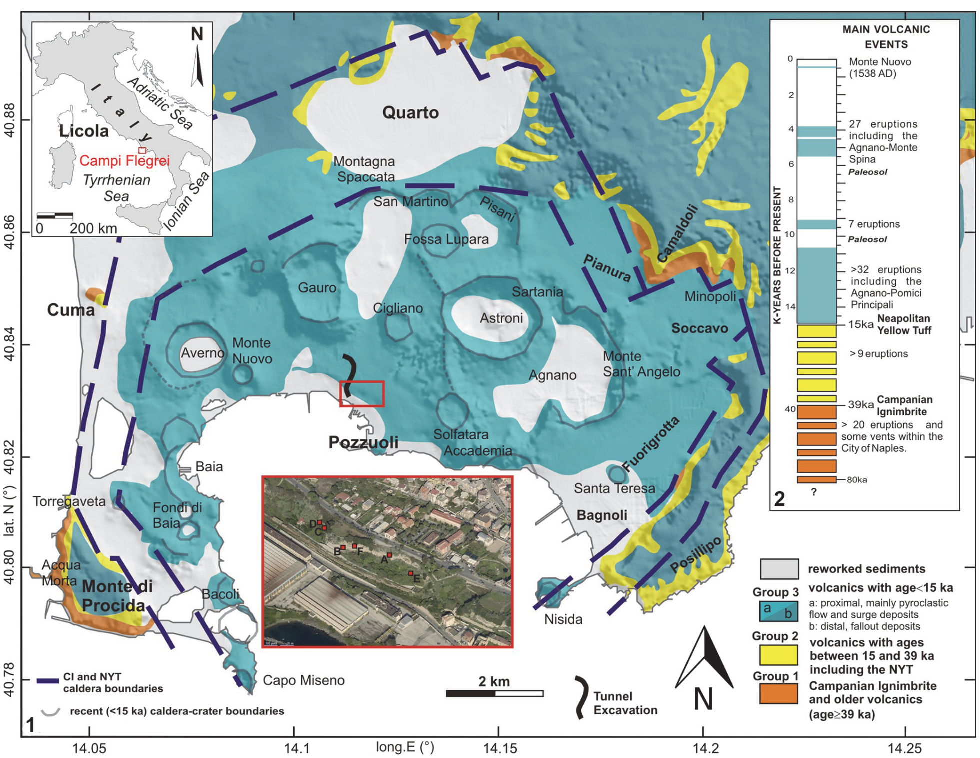

FIGURE 1. 1) Schematic geological map of Campi Flegrei (after Vitale and Isaia, 2014, modified); location of the sections and of the Tunnel Excavation. 2) Chronology of the main volcanic events in the CF.

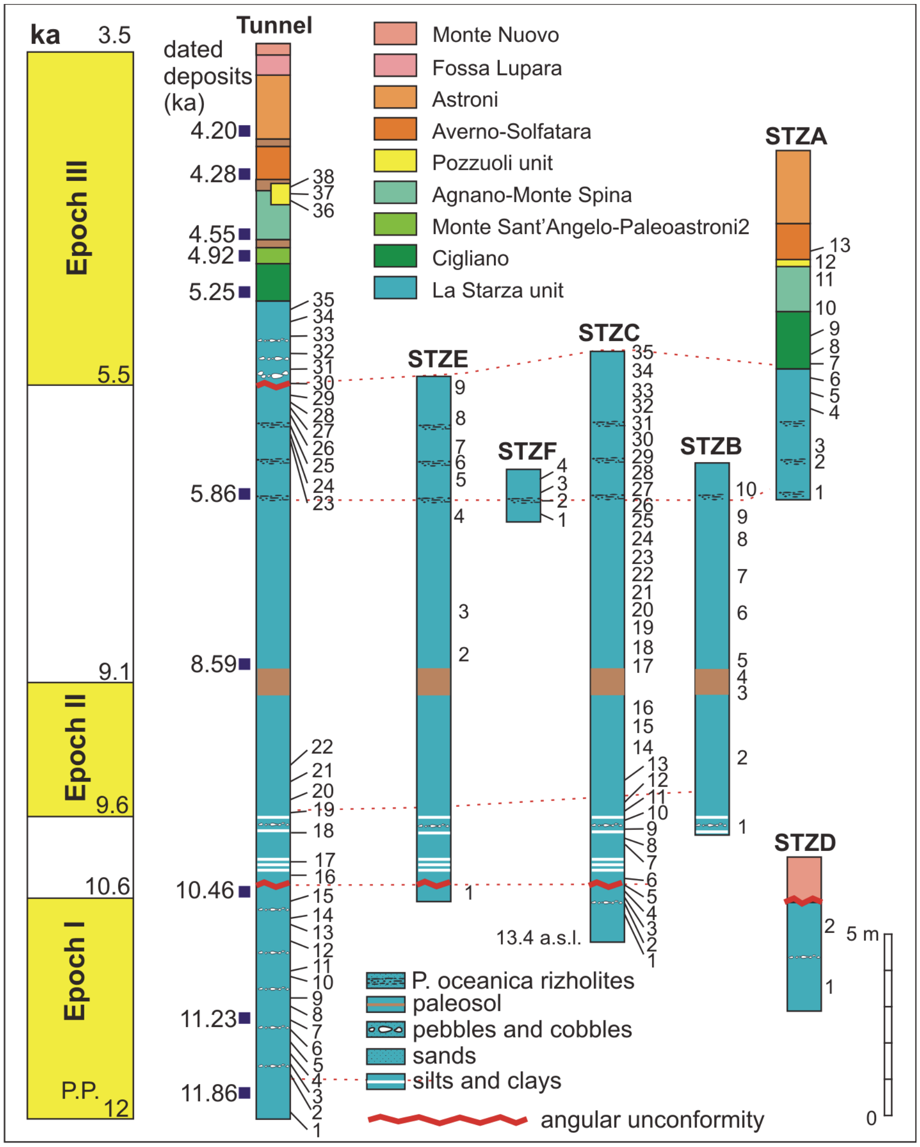

FIGURE 2. Chronostratigraphic correlation of the La Starza sections (including Tunnel Section) with sampling location and dated levels. Chronostratigraphic data are according Rosi and Sbrana, 1987; Giudicepietro, 1993; Di Vito et al., 1999; de Vita et al., 1999; Isaia et al., 2009; Passariello et al., 2010; Smith et al., 2011.

last volcanic event, the Monte Nuovo eruption, occurred in 1538, forming in few days a cone tuff located in the western part of the town of Pozzuoli. The deposits of this eruption locally cap the sequences of the La Starza Terrace.

The presence of well exposed marine sediments at La Starza have promoted the paleontological studies since the brief notes of Scacchi (1841, 1849) and the investigations of Costa (1853a, b) who presented lists of both foraminiferal and ostracod species. Further data on fossil assemblages were reported by De Angelis D'Ossat (1894), De Lorenzo and Simotomai Tanakadate (1915; also including a list of species previously compiled by Charles Babbage), Bellini (1929) and Minieri (1950). The first modern study of the fossil assemblages of the La Starza deposits was carried out by Rodriquez (1964), focusing mainly on molluscs and foraminifers. In more recent times contributions on foraminifer and ostracod assemblages have been carried out by Amore et al. (1988, 1990) and Ciampo (2004).

MATERIAL AND METHODS

One hundred and seven samples have been collected from six sections of the La Stanza Cliff (Figures 1-2) and from several tunnel excavation fronts (from here onwards referred to as "Tunnel Section") for micropaleontological analyses with special regard to benthic foraminiferal and ostracod assemblages.

The Tunnel Section, ~31.5 m thick, consists of deposits ranging from Epoch I to Epoch III; 38 samples were collected. Section D (thickness: 4.3 m) deposited during Epoch I and the first rest interval; two samples pertain to this section. Both Section C (thickness: 16.3 m) and Section E (thickness: 14.5 m) range from the upper part of Epoch I to the base of Epoch III; in the Section C 35 samples have been studied, five belong to the Section E. Section B, 10.3 m thick, includes deposits pertaining to the first period of volcanic quiescence, Epoch II and second rest phase; 10 samples were collected in this section. Section F is a short section (1.5 m) entirely deposited during the second quiescent phase; four levels were sampled. The Section A ranges from the last part of the second rest phase to Epoch III, with a thickness of 9.7 m; 13 samples were collected.

Ages of volcanic and marine deposits cropping out in the La Starza cliff, reported in Figure 2, derive from literature data (Rosi and Sbrana, 1987; Giudicepietro, 1993; Di Vito et al., 1999; de Vita et al., 1999; Isaia et al., 2009; Passariello et al., 2010; Smith et al., 2011). Stratigraphic data show that the age of the succession ranges from ~12 to ~4 k.y.a, locally overlain by the deposits of the historical Monte Nuovo eruption (Figure 2). The Pomici Principali deposits (~12.3 k.y.a) do not outcrop either in the sections or in the Tunnel Section.

All the sediment samples (200 g – dried weight) were disaggregated in boiling water with sodium carbonate, washed through 230 and 120 mesh sieves (63 and 125 μm, respectively) and the residue examined under transmitted light microscope. Diatoms, molluscs, bryozoans, echinoderms, planktonic foraminifers, sponges, radiolarians and serpulids occurrences have been reported as semiquantitative data (Table 1 - please note Tables 2–7 are supplied as spread sheets in one zipped file online). When possible a minimum of 300 benthic foraminiferal specimens and ostracod valves were picked from the coarsest fraction (> 125 μm) and counted for quantitative analysis. A microsplitter was used to obtain subsamples when necessary. Data consist of number of foraminifer specimens (Tables 2, 3) and ostracod Minimum Number of Individuals (MNI, Tables 4, 5) and Total Number of Valves (TNV, Tables 6, 7). MNI is the greater number between right and left adult valves plus the number of adult carapaces; when only juvenile shells are recorded the MNI equals one. TNV includes all the juvenile and adult valves.

The species have been identified according to classic and modern literature both for benthic foraminifers (i.a., Sen Gupta et al., 2009a; Hayward et al., 2010; Debenay, 2012; Milker and Schmiedl, 2012) and, with special regard to the Mediterranean area, for ostracods (i.a. Bonaduce et al., 1976a; Breman, 1976; Aiello and Barra, 2010). Species are listed in Appendix 1.

Discrimination of autochthonous and allochthonous ostracod species was based on the state of preservation, the available distribution data and the presence of shells belonging to different development stages. Allochthonous species (not considered for paleoenvironmental analysis) and their distributions are summarized in Table 8.

Paleoecological reconstructions have been carried out taking into account semiquantitative and quantitative data, the latter analysed using the free software PAST version 3.01 (Hammer et al., 2001). Q-mode cluster analysis was performed only on samples of the Section C that yielded both benthic foraminiferal and ostracod remains; it has been applied to benthic foraminiferal and ostracod assemblage data using the Bray-Curtis similarity coefficient. Benthic foraminiferal and ostracod species with relative abundance greater than 5% in at least one sample have been considered.

The comparison among statistical analyses, taxonomic composition, assemblage features, literature data and unpublished data from north-western coastal areas of the Campania Region, allowed the evaluation of paleoenvironmental variations. We have taken in account assemblage parameters summarized in Table 9 and reported in Tables 10-12, that are: Abundance (I), Relative Abundance (RA), Dominance (D), Diversity (S, H'), Equitability (J), *Ammonia-Elphidium* Index (AE), Foraminifer-Ostracod Ratio (FO), Circalittoral Foraminifer Relative Abundance (CFRA), Circalittoral Ostracod Relative Abundance (CORA) and Tolerant Foraminifer Relative Abundance (TFRA). The studied specimens are housed in the Aiello Barra Micropaleontological Collection (A.B.M.C.), Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Università degli Studi di Napoli Federico II.

RESULTS

The lowest outcropping deposits of the La Starza succession consist of alternating fine, medium and coarse-grained sands (1 m thick), passing upward into medium coarse sands, 2.5 m

TABLE 1. Semiquantitative distribution of microfossils remains (VR=very rare; R=rare; U=uncommon; C=common).

Section	Samples	Bacillariophyta	Bivalvia	Bryozoa	Echinodermata	Foraminifera (benthic)	Foraminifera (planktonic)	Gastropoda	Ostracoda	Porifera	Radiolaria	Serpulidae
Tunnel excavation	Tun 2									VR		
	Tun 22									C		
	Tun 23	VR								VR		
	Tun 27									U		
	Tun 35									U		
STZC	STZC 7					VR				VR		
	STZC 9									VR	VR	
	STZC 13					U				VR		
	STZC 15				U	U	R	VR	R	R		
	STZC 16	VR	R		VR	R		R	VR	U		
	STZC 17		A		U	R		C	VR			C
	STZC 18	R	U		R	C	R	R	R	C	R	
	STZC 19		U		C	C	R	U	U	U	R	
	STZC 20		C		U	C	R	C	C	C	R	
	STZC 21		R		U	C	R	R	U	U	R	
	STZC 22		R		U	C	R		C	C	R	
	STZC 23	VR	R		R	C	R	VR	U	U		
	STZC 24	R	VR		U	C	R	VR	C	U	R	
	STZC 25				R	C	R		U	U	VR	VR
	STZC 26	R			U	C	U		C	U	VR	
	STZC 27	VR			U	U	R		U	U	R	VR
	STZC 28	VR	R		U	C	R		U	U	U	
	STZC 29	R	R		U	C	R	R	C	U	R	VR
	STZC 30	VR	U		C	C	R		U	U	R	
	STZC 31	VR			U	C	U		U	C		
	STZC 32	VR	R		U	U	VR		U	U		VR
	STZC 33	U	U		R	C			C	U	U	
	STZC 34	R			U	C	U		C	C	U	
	STZC 35									C		
STZE	STZE 1		C	VR	U	C	R	U	R	C		R

thick, in places characterized by cross-lamination and pumice lenses. They are covered by a 1 m thick level of yellowish laminated silt and fine sand, in turn overlain by 2 m of medium to coarse sands and pumice lenses, topped by medium-coarse orange-brownish massive sands, 3 m thick.

In the tunnel excavation the lowest part of the succession shows fine-medium grained sands followed by coarse-grained channelized sands passing, through a flat-lying unconformity, to fine sediments that correspond to the yellowish level outcropping in the La Starza cliff. In both Tunnel Section and La Starza cliff the sequence continues with medium to fine massive sands (5 m thick) containing anthozoan, mollusc and echinoid remains, and with three layers of fine to medium sands with

TABLE 1 (continued).

	STZE 2		VR		U	C	R			C	VR	
	STZE 3	VR	VR							C		
	STZE 4		VR							U		R
	STZE 5									C		VR
STZB	STZB 2									VR		
	STZB 3									VR		
	STZB 4									U		
	STZB 5	R	C		VR	C		U	U	C	R	
	STZB 6	U			R	C	U		U	C	U	
	STZB 7									C	C	
	STZB 8									C	U	
	STZB 9									U	R	
	STZB 10									R	VR	VR
STZF	STZF1	R			U	C				C	R	
	STZF2				R	R				R		VR
	STZF3	VR			U	R	VR			R	R	
	STZF4	R			C	C	R		R	C		
STZA	STZA1									C	R	
	STZA2	U				VR				C	U	
	STZA3									R		
	STZA4	R								C	R	
	STZA5	U								C	R	
	STZA6	R								U	R	
	STZA7		R							R		

rounded pumice lenses, with a total thickness of ~3 m, separated from the underlying deposits by a sharp surface. These sediments yield *Posidonia oceanica* and ostreid remains. In the Tunnel Section the marine sands abruptly pass upward, through an angular unconformity, to coarse grained sands and stratified layers containing pumices and rounded lava pebbles, whereas in the La Starza cliff they are upward confined by an erosional surface followed by pyroclastic deposits. A sequence mainly composed of volcanic deposits caps the succession. Its lower part contains coarse ash beds and pumice lenses with cross-lamination and sandwave structures, passing to plane-parallel ash layers. Pyroclastic deposits, correlated with volcanic events (Figure 2), are separated by erosional unconformities or thin paleosols. In the Tunnel Section laminated reworked sands occur between the Agnano-Monte Spina and Averno-Solfatara deposits. They locally show asymmetric ripples

TABLES 2–7 are supplied as spread sheets in one zipped file online. https://palaeo-electronica.org/content/2018/499-835/2344-la-starza-forams-and-ostracods-tables

TABLE 2. Benthic foraminifer absolute abundance (I).

TABLE 3. Benthic foraminifer relative abundance (RA,%).

TABLE 4. Ostracod absolute abundance (I) (MNI); * indicates juvenile specimens.

TABLE 5. Ostracod relative abundance (RA,%) (MNI).

TABLE 6. Ostracod absolute abundance (I) (TNV).

TABLE 7. Ostracod relative abundance (RA,%) (TNV).

TABLE 8. Allochthonous ostracod taxa occurrences.

sections	STZC															STZF
samples	STZC20	STZC21	STZC22	STZC23	STZC24	STZC25	STZC26	STZC27	STZC28	STZC29	STZC30	STZC31	STZC32	STZC33	STZC34	STZF4
Candona neglecta Sars, 1887			•							•						
Candonidae									•							
Cyclocypris sp.				•												
Cypria sp.				•												
Cyprideis torosa (Jones, 1850)								•	•	•	•		•	•	•	•
Cypridopsis sp.										•						
Cypris pubera O.F. Müller, 1776									•	•	•	•		•		
Heterocypris sp.									•							
Mixtacandona sp.			•													
Pseudocandona sarsi (Hartwig, 1899)										•						

TABLE 9. Description and references of assemblage features.

Assemblage feature	Description	References
Absolute Abundance (I)	Individuals/100 grams of dried sediment	
Relative Abundance (RA)	Species percentage	
Dominance (D)	Simpson index of dominance	Hammer and Harper 2006, Hammer 1999-2016
Equitability (J)	Shannon diversity divided by the logarithm of number of taxa	Hammer and Harper 2006, Hammer 1999-2016
Shannon H' (H')	Shannon-Wiener Diversity Index (entropy)	Hammer and Harper 2006, Hammer 1999-2016.
Taxa S (S)	**Number of species (Species Richness or Simple Diversity)**	
A-E Index (AE)	*Ammonia-Elphidium* Foraminiferal Index (*Aubignyna perlucida* has been included in *Ammonia*)	Sen Gupta et al. 1996; Sen Gupta and Platon, 2006
F-O Ratio (FO)	Foraminifer individuals/Ostracod individuals	
CFRA	Circalittoral Foraminifer Relative Abundance: sum of relative abundance of benthic foraminifer species showing preference for circalittoral waters, with a relative abundance > 3% at least in one sample (*Bulimina aculeata, B. marginata, Cassidulina carinata, Nonionella turgida* and *Reussella spinulosa*)	
CORA	Circalittoral Ostracod Relative Abundance: sum of relative abundance of ostracod species showing preference for circalittoral waters, with a relative abundance > 3% at least in one sample (*Costa edwardsii, Cytheridea neapolitana, Rectobuntonia subulata* and *Semicytherura ruggierii*)	
TFRA	Tolerant Foraminifer Relative Abundance: sum of relative abundance of benthic foraminifer showing tolerance to stressed and/or low-oxygen conditions, with a relative abundance > 3% at least in one sample (*Ammonia aberdoveyensis* lobate form*, A. beccarii*, *A. falsobeccarii*, *Amphicoryna scalaris*, *Aubignyna perlucida*, *Bolivina lowmani*, *B. pseudoplicata*, *B. variabilis*, *Brizalina spathulata*, *Bulimina aculeata*, *B. elongata*, *B. marginata*, *Cassidulina carinata*, *Cornuspira involvens*, *Elphidium poeyanum* DS form, *E. pulvereum*, *E. incertum*, *Epistominella vitrea*, *Fursenkoina subacuta*, *Globocassidulina subglobosa*, *Haynesina depressula*, *H. germanica*, *Nonion fabum*, *Nonionella turgida*, *Rectuvigerina phlegeri*, *Valvulineria complanata*).	

and are covered, through an unconformable surface, by coarse sands showing tabular cross lamination, correlated with a discontinuous humified dark grey sandy layer, with a maximum thickness of 30 cm, outcropping in the La Starza cliff (Section A). These levels can be assigned to the Pozzuoli unit.

Fifty-four samples resulted fossiliferous and 53 barren. Sediments of the Tunnel Section and of the sections A and D are very poor or completely devoid of fossil remains. Rich and well diversified assemblages were found mainly in Section C and are retained for statistical analyses thereof. Fossil content consists of calcareous assemblages,

TABLE 10. Benthic foraminifer assemblage indices.

Sections	Samples	Taxa S	Abundance I	Dominance D	Shannon H'	Equitability J	A-E index AE	CFRA	TFRA
STZC	STZC 7	1	1	-	-	-	-	-	-
	STZC 13	19	1888	0.12	2.36	0.80	66.67	5.08	39.83
	STZC 15	30	436	0.09	2.72	0.80	18.75	22.02	39.45
	STZC 16	12	124	0.13	2.22	0.89	23.08	0.00	32.26
	STZC 17	18	164	0.08	2.72	0.94	32.26	0.00	31.71
	STZC 18	41	30144	0.07	3.02	0.81	35.92	25.69	60.93
	STZC 19	36	10848	0.06	3.02	0.84	47.18	25.66	46.90
	STZC 20	38	16672	0.10	2.72	0.75	18.12	23.99	47.60
	STZC 21	30	10944	0.11	2.58	0.76	15.34	26.61	54.39
	STZC 22	30	4960	0.10	2.63	0.77	16.11	31.29	52.58
	STZC 23	30	6496	0.08	2.77	0.81	21.10	21.67	52.22
	STZC 24	36	4864	0.10	2.77	0.77	25.32	24.34	53.29
	STZC 25	32	5328	0.09	2.84	0.82	29.57	36.94	54.05
	STZC 26	37	4400	0.08	2.93	0.81	25.27	32.00	54.55
	STZC 27	33	688	0.07	3.04	0.87	19.30	22.09	54.07
	STZC 28	44	9472	0.06	3.21	0.85	35.29	22.97	49.66
	STZC 29	44	9736	0.06	3.12	0.82	39.08	22.93	49.73
	STZC 30	38	7840	0.05	3.17	0.87	46.03	17.55	38.37
	STZC 31	39	11968	0.05	3.27	0.89	24.42	20.86	47.06
	STZC 32	31	390	0.06	3.03	0.88	30.34	16.41	32.82
	STZC 33	44	15040	0.05	3.29	0.87	28.45	24.04	48.72
	STZC 34	48	22336	0.04	3.43	0.89	9.71	25.50	48.14
STZE	STZE1	26	5232	0.10	2.639	0.81	25.11	13.76	43.73
	STZE2	24	2088	0.11	2.527	0.80	21.60	16.48	55.56
STZB	STZB 5	37	5024	0.08	2.91	0.81	16.77	20.70	50.64
	STZB 6	32	10256	0.10	2.65	0.77	20.43	30.89	57.57
STZF	STZF1	31	2344	0.08	2.85	0.83	29.79	19.80	49.15
	STZF2	7	64	0.25	1.66	0.85	33.33	0.00	18.75
	STZF3	9	104	0.13	2.11	0.96	30.00	7.69	42.31
	STZF4	34	1164	0.06	3.08	0.87	43.93	20.27	50.86
STZA	STZA2	1	1	-	-	-	-	-	-

including benthic and planktonic foraminifers, ostracods, mollusc shells (mainly tiny fragments), serpulid tubes and echinoderm spines, and siliceous remains of diatoms, radiolarians and sponge spicules. Foraminifers occur in 31 samples whereas ostracods in 24. The genera *Ammonia* and *Elphidium* (foraminifers) and trachyleberid ostracods generally dominate the assemblages.

The general features of micropaleontological assemblages of the sections are as follows.

Tunnel Succession. It includes samples collected in subsections linked to some excavation fronts of the Tunnel. Most of the samples (Tun 1, 3-21, 24-26, 28-34, 36-38) were barren. The remaining five samples yielded assemblages dominated by siliceous remains. Tun 2, 22, 27 and 35 consisted almost exclusively of sponge spicules. Tun 23 also contained large diatoms.

TABLE 11. Ostracod (MNI) assemblage indices.

Sections	Samples	Taxa S	Abundance I	Dominance D	Shannon H'	Equitability J	CORA	FO
STZC	STZC 15	1	16	1	-	-	-	27.25
	STZC 16	1	4	1	-	-	-	31.00
	STZC 17	1	1	1	-	-	-	164.00
	STZC 18	5	103	0.44	1.00	0.62	89.32	292.66
	STZC 19	13	361	0.22	1.95	0.76	55.40	30.05
	STZC 20	17	691	0.13	2.26	0.80	23.30	24.45
	STZC 21	15	227	0.18	2.05	0.76	19.82	49.97
	STZC 22	12	270	0.20	1.86	0.75	22.22	18.65
	STZC 23	21	207	0.11	2.45	0.80	15.94	32.48
	STZC 24	14	207	0.16	2.06	0.78	28.99	23.96
	STZC 25	22	229	0.08	2.76	0.89	27.95	25.01
	STZC 26	16	218	0.11	2.39	0.86	25.69	20.37
	STZC 27	28	87	0.06	3.04	0.91	18.39	8.49
	STZC 28	27	289	0.08	2.81	0.85	14.19	34.07
	STZC 29	24	130	0.15	2.54	0.80	37.69	82.68
	STZC 30	22	117	0.10	2.72	0.88	27.35	75.38
	STZC 31	31	422	0.11	2.60	0.76	34.60	30.93
	STZC 32	27	86	0.07	2.96	0.90	8.14	5.16
	STZC 33	26	1061	0.08	2.76	0.85	24.13	14.43
	STZC 34	21	741	0.13	2.39	0.79	45.34	31.64
STZE	STZE1	5	33	0.35	1.24	0.77	30.30	159.00
STZB	STZB 5	6	52	0.35	1.31	0.73	15.38	96.62
	STZB 6	7	41	0.46	1.17	0.60	80.49	250.15
STZF	STZF4	4	8	0.34	1.21	0.88	50.00	146.00

Section D. The two layers sampled in the Section D (STZD 1-2) resulted devoid of microfossil remains.

Section C. In the lower part of the section (samples STZC 1-6) microfossil assemblages are not present. The overlying interval displays an alternation of fossiliferous and barren layers (STZC 7-14). The samples STZC 8, STZC 10-12 and STZC 14 are devoid of fossil remains. In the remaining samples the assemblages are generally poor and consist of rare sponge spicules associated with radiolarians (STZC 9) or benthic foraminifers (STZC 7, STZC 13). In the sample STZC 7 foraminifers are represented by a single specimen of *Elphidium granosum*; the assemblage recorded in the sample STZC 13 consists of 19 species, the most abundant being *Ammonia aberdoveyensis* rounded form, *A. aberdoveyensis* lobate form, *Ammonia falsobeccarii*, *Elphidium poeyanum* FS form (i.e., morph with flush sutures; v. systematic section) and *Buccella granulata*. RA of the genera *Ammonia* (50.85%) and *Elphidium* (25.42%) are very high. The A-E index is high (66.67), whereas diversity H' (2.36) and CFRA (5.08%) are very low. Ostracod shells have not been recorded in this interval.

In the upper part of the section, that includes all the samples (STZC 15-34) showing the co-occurrence of benthic foraminiferal and ostracod assemblages, abundance and diversity are relatively high. Statistical analyses have been performed on the assemblages pertaining to this interval (see below). Ostracod assemblages display (Figure 3) a discontinuous decrease of dominance, and an increase of diversity H', simple diversity S and Equitability J, up to the sample STZC 27 (H'=3.04, S=28, D=0.06; J=0.91 both MNI and TNV). In comparison with the ostracod assemblages, foraminifers generally show higher diversity and lower dominance values. A remarkable peak of circalittoral taxa is recorded in sample 25 (CFRA=36.94%; CORA(MNI)=27.95%; CORA(TNV)=51.87%), whereas very low values occur in the sample 32 (CFRA=16.41%;

TABLE 12. Ostracod (TNV) assemblage indices.

Sections	Samples	Taxa S	Abundance I	Dominance D	Shannon H'	Equitability J	CORA	FO
STZC	STZC 15	1	42	1	-	-	-	10.38
	STZC 16	1	4	1	-	-	-	31.00
	STZC 17	1	8	1	-	-	-	20.50
	STZC 18	5	240	0.43	1.07	0.67	86.67	125.60
	STZC 19	13	1328	0.32	1.67	0.65	68.07	8.17
	STZC 20	17	2632	0.15	2.17	0.77	30.70	6.37
	STZC 21	15	764	0.23	1.82	0.67	40.31	14.48
	STZC 22	12	1008	0.20	1.86	0.75	28.57	4.96
	STZC 23	21	945	0.14	2.34	0.77	15.66	7.06
	STZC 24	14	720	0.19	2.03	0.77	42.78	6.79
	STZC 25	22	964	0.20	2.24	0.73	51.87	5.72
	STZC 26	16	672	0.15	2.17	0.78	37.50	6.67
	STZC 27	28	332	0.06	3.04	0.91	16.27	2.53
	STZC 28	27	1112	0.12	2.63	0.80	32.37	9.18
	STZC 29	24	367	0.25	2.14	0.67	50.14	29.56
	STZC 30	22	450	0.23	2.18	0.70	46.22	18.15
	STZC 31	31	1984	0.18	2.42	0.70	46.37	6.53
	STZC 32	27	222	0.08	2.82	0.86	13.51	2.48
	STZC 33	26	4544	0.13	2.48	0.76	46.83	3.49
	STZC 34	21	2336	0.17	2.17	0.71	50.68	9.86
STZE	STZE1	5	52	0.32	1.27	0.79	38.46	100.62
STZB	STZB 5	6	119	0.30	1.36	0.76	16.81	42.22
	STZB 6	7	117	0.63	0.81	0.41	88.89	87.66
STZF	STZF4	4	16	0.44	1.07	0.77	62.50	72.75

CORA(MNI)=8.14%; CORA(TNV)=13.51%). In the upper part of this interval no clear indices trend is evident. The samples STZC 18-34 were the most reliable for paleoecological interpretation (Figure 3). In all the samples are present echinoderm spines; in the main part of the samples sponge spicules, planktonic foraminifers, molluscs, radiolarians, diatoms and serpulids are associated in decreasing order of frequency.

The uppermost sample of the Section C, STZC 35, yielded exclusively common sponge spicules.

Section E. The lowermost sample (STZE 1) yielded siliceous and calcareous remains, including foraminifers, ostracods, sponge spicules, bryozoan and mollusc remains, echinoderm spines. Middle abundance and diversity foraminiferal assemblage and low abundance and diversity ostracod assemblage are recorded. The foraminiferal species *E. granosum, Elphidium crispum, Elphidium excavatum, A. aberdoveyensis* lobate form and the ostracods *Costa edwardsii* and *Semicytherura incongruens* dominate the assemblage. Diversity indices are low for foraminiferal and very low for ostracod assemblages; ostracod D and FO are very high, CFRA low.

In the sample STZE 2 foraminifers, sponge spicules, echinoderm spines occur. The foraminiferal assemblage, characterized by low H', low CFRA and high TFRA, is dominated by *E. granosum, Nonionella turgida, E. poeyanum* DS form, *A. aberdoveyensis* lobate form. Ostracods are not present.

Assemblages of the samples STZE 3-5 consist mostly of siliceous sponge spicules. Neither ostracod nor foraminiferal remains occur.

Section B. The sample STZB 1 is devoid of fossil remains, whereas in the samples STZB 2-4 minute siliceous sponge spicules occur. Samples STZB 5 and STZB 6 yielded siliceous and calcareous remains, including foraminifers, ostracods, diatoms, radiolarians, sponge spicules and echinoderm spines. Benthic foraminiferal assemblages show middle abundance and diversity values;

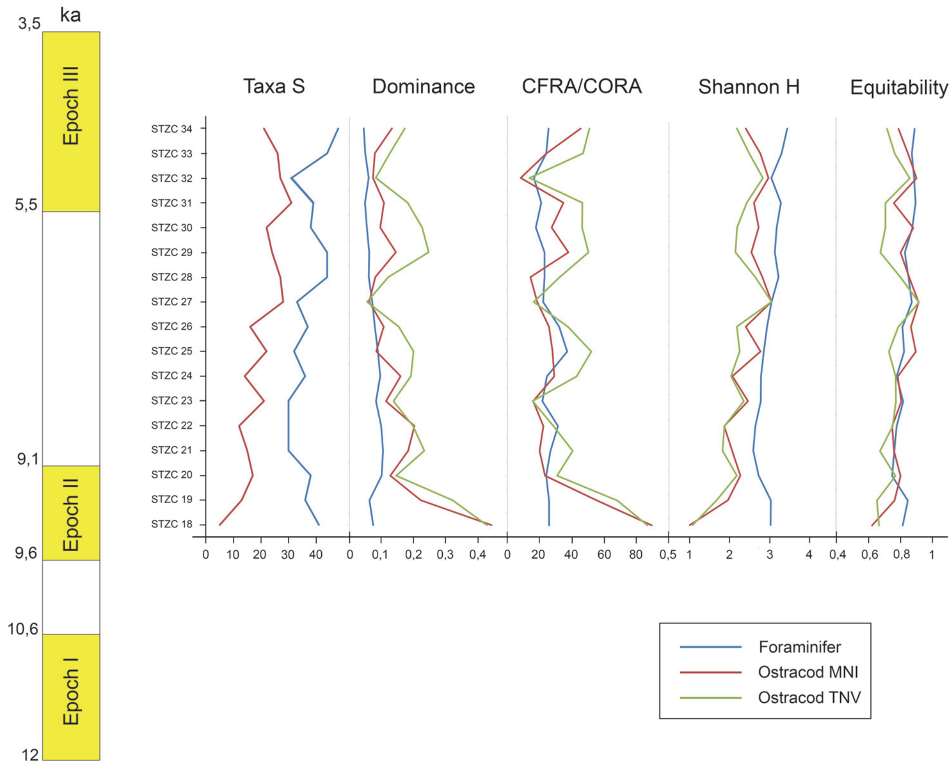

FIGURE 3. Benthic foraminiferal and ostracod assemblage trends in Section C (samples STZC 18 - STZC 34). See text and Table 9 for details.

ostracod assemblages are characterized by high dominance and low diversity/abundance values. FO values are very high (MNI=96.62-250.15; TNV=42.22-87.66).

The most abundant species are the foraminifer *N. turgida* (14.65-18.88%), *E. granosum* (12.95-15.92%), *E. poeyanum* DS form (7.96-11.7%) and *A. aberdoveyensis* lobate form (8.28-9.67%); ostracod assemblages are dominated by *C. edwardsi* (MNI = 15.38-65.85%; TNV = 16.81-78.63%) and *S. incongruens* (MNI = 4.88-53.85%; TNV = 2.56-42.86%). CFRA, CORA and TFRA values are moderately high. The assemblages of the uppermost part of the section (sample STZB 7-10) consist almost exclusively of siliceous remains (sponge spicules and radiolarians).

Section F. The sample STZF 1, collected at the base of the section, yielded siliceous and calcareous microfossil remains, with sponge spicules, foraminifers and echinoderm spines. Foraminiferal assemblage dominated by *N. turgida, E. crispum, A. aberdoveyensis* lobate form and *E. poeyanum* DS form, shows middle abundance and diversity, moderately low CFRA and high TFRA. Ostracods are not present. The benthic foraminiferal assemblages of the samples STZF 2-3 display low abundance and diversity, high dominance and very low CFRA (0-7.69%). Siliceous sponge spicules and echinoderm spines are present whereas ostracods lack. The uppermost sample (STZF 4) of the section F yielded both benthic foraminiferal and ostracod assemblages. Ostracod assemblage is poor, with high CORA, and F-O ratio is very high. CFRA reaches the maximum value of the Section F (20.27%).

Section A. In the samples STZA 1-7 siliceous remains (diatoms, sponge spicules and radiolarians) dominate largely the assemblages, whereas the sediments of the upper part of the section (STZA 8-13) are barren.

Statistical Analysis

The samples pertaining to the middle-upper part of the Section C (STZC 15-34) are characterized by the presence of both benthic foraminifer and ostracod remains. Cluster analysis (Bray-Curtis similarity coefficient) was performed on foraminiferal and ostracod (both MNI and TNV) assemblages (Figures 4-6). Results, used for paleoenvironmental reconstruction (Figure 7), are slightly different for benthic foraminifer and ostracod analysis.

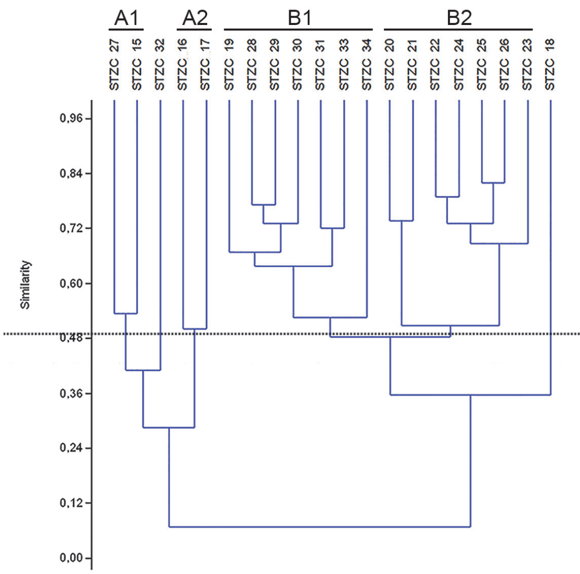

FIGURE 4. Dendrogram based on cluster analyses of benthic foraminifer abundance (I) data.

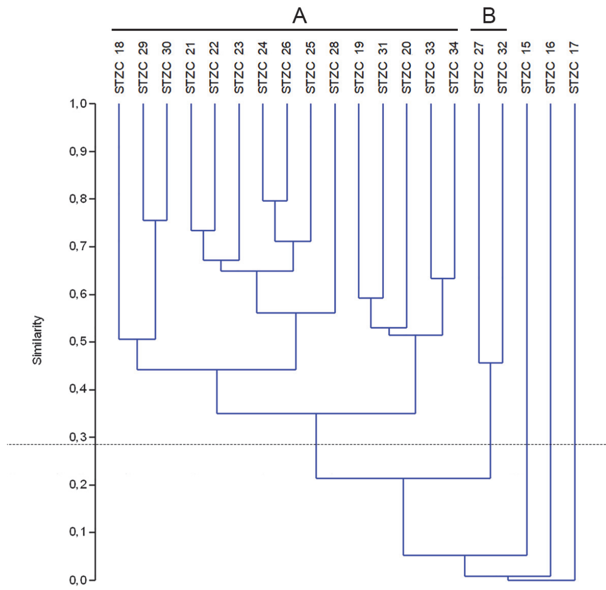

FIGURE 6. Dendrogram based on cluster analyses of ostracod abundance (I) data (TNV).

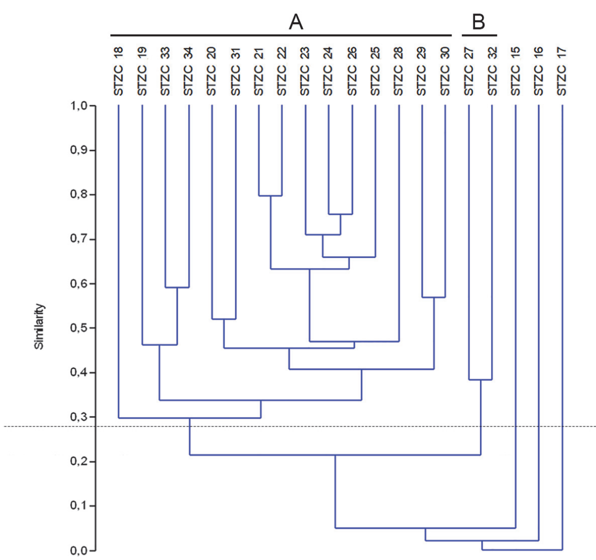

FIGURE 5. Dendrogram based on cluster analyses of ostracod abundance (I) data (MNI).

Foraminifers. The foraminifer dendrogram (Figure 4) displays two main clusters, the first (A) including STZC 15-17, STZC 27 and STZC 32, and the second (B) all the remaining assemblages.

Cluster A. The five assemblages of the Cluster A are characterized by low abundances (I=124-688). It includes two subclusters: A1 (Samples STZC 15, 27) and A2 (STZC 16, 17); STZC 32 is individually discriminated. Subcluster A1 consists of the samples with high CFRA (22.02%-22.09%) and characterized by high abundances of *Asterigerinata adriatica* (5.23%-15.14%) and *N. turgida* (16.06%-18.02%). A2 shows low simple diversity and abundance assemblages (S=12-18; I=124-164). The sample 32 displays the lowest dominance (0.06) and highest RA of *B. granulata* (12.1%) and A-E index (30.34).

Cluster B. The fifteen assemblages of the Cluster B are characterized by high abundances (I=4400-30144). The sample STZC 18 is individually discriminated, showing high abundance-diversity values; TFRA, CFRA and AE are from high to very high. Two subclusters are discernible.

The Subcluster B1 includes the samples STZC 19, STZC 28-31, STZC 33-34. Foraminifer assemblages show high abundance (7840-22336), diversity (S=36-48; H=3.02-3.43), equitability (J=0.82-0.89) and low dominance (D=0.04-0.06). The most represented species are *N. turgida* (10.16-16.55%), *Reussella spinulosa* (3.19-10.03%), *Haynesina depressula* (2.77-8.29%) and *B. granulata* (2.86-8.67%). Subcluster B2 consists of samples STZC 20-26. Foraminifer abundance and diversity show moderately low values; dominance is high (D=0.08-0.11), FO low (MNI=18.65-49.97; TNV=4.96-14.48). *Elphidium* species show high percentages in all the samples (21.09-44.74%) and the *Ammonia-Elphidium* index is low, ranging from 14.04 to 31.19. The commonest foraminifer species are *N. turgida* (6.90-21.92%), *Bulimina elongata* (6.31-10.34%), *E. granosum* (6.31-21.50%), *A. aberdoveyensis* lobate form

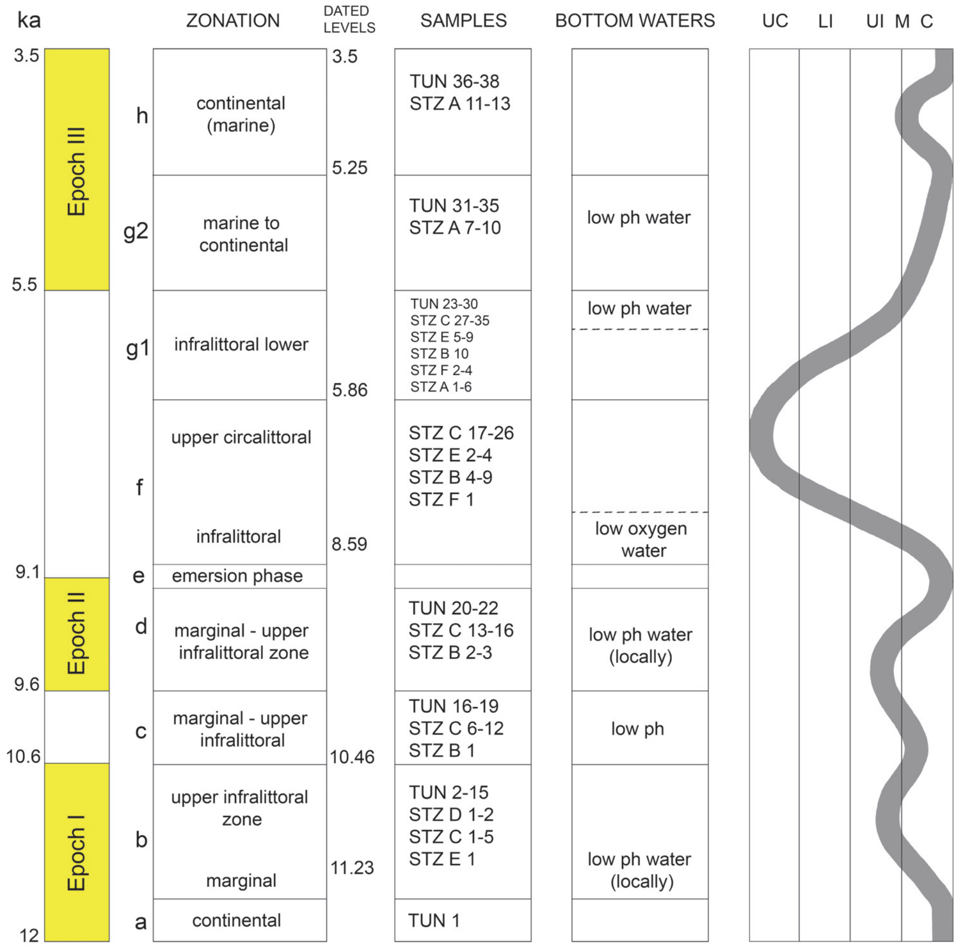

FIGURE 7. Paleoecological events through the La Starza succession and paleobathymetry trends. UC: upper circalittoral; LI: lower infralittoral; UI: upper infralittoral; M: marginal; C: continental.

(5.67-11.51%), *E. poeyanum* DS form (5.41-16.96%) and *R. spinulosa* (5.26-11.94%).

Ostracods. The ostracod dendrograms (MNI and TNV; respectively Figure 5 and Figure 6) are similar. The samples STZC 15, 16 and 17 are individually discriminated. In all these samples ostracods are represented by a single species. Two clusters have been recognized. The Cluster A consists of the samples STZC 18-26, STZC 28-31, STZC 33-34. Ostracod diversity indices and abundance, as well as FO, display a wide range (S=5-31; I(MNI)=103-1061; I(TNV)=240-4544; FO(MNI) = 14.43-292.66; FO(TNV)=3.49-125.6; CORA(MNI)=14.19%-89.32%; CORA(TNV) = 15.66%-86.67%). Ostracod assemblages are characterized by *C. edwardsi* (RA(MNI)=7.54%-58.25%; RA(TNV)=13.54%-58.33%), *Cistacythereis turbida* (RA(MNI)=4.32%-19.32%; RA(TNV)=2.05%-13.10%), *Carinocythereis whitei* (RA(MNI)=3.79%-34.07%; RA(TNV)=3.01%-29.76%) and *Pseudopsammocythere reniformis* (RA(MNI)=0.85%-15.46%; RA(TNV)=0.68%-14.29%).

Cluster B includes the samples STZC 27 and STZC 32. Their assemblages are characterized by low abundance (I(MNI)=86-87; I(TNV)=222-332), high diversity (S: 27-28; H'(MNI)=2.96-3.04; H'(TNV)=2.82-3.04), low CORA (MNI=8.14%-18.39%; TNV=13.51-16.27%) and FO (MNI=5.16-8.49; TNV=2.48-2.53). *Loxoconcha ovulata* is well represented (RA(MNI)=4.60 -18.60%; RA(TNV)=6.63%-17.12%).

NOTES ON TAXONOMY AND ECOLOGY

Order FORAMINIFERIDA von Eichwald, 1830
Suborder MILIOLINA Delage and Herouard, 1896
Family CORNUSPIRIDAE Schultze, 1854
Subfamily CORNUSPIRINAE Schultze, 1854
Genus CORNUSPIRA Schultze, 1854

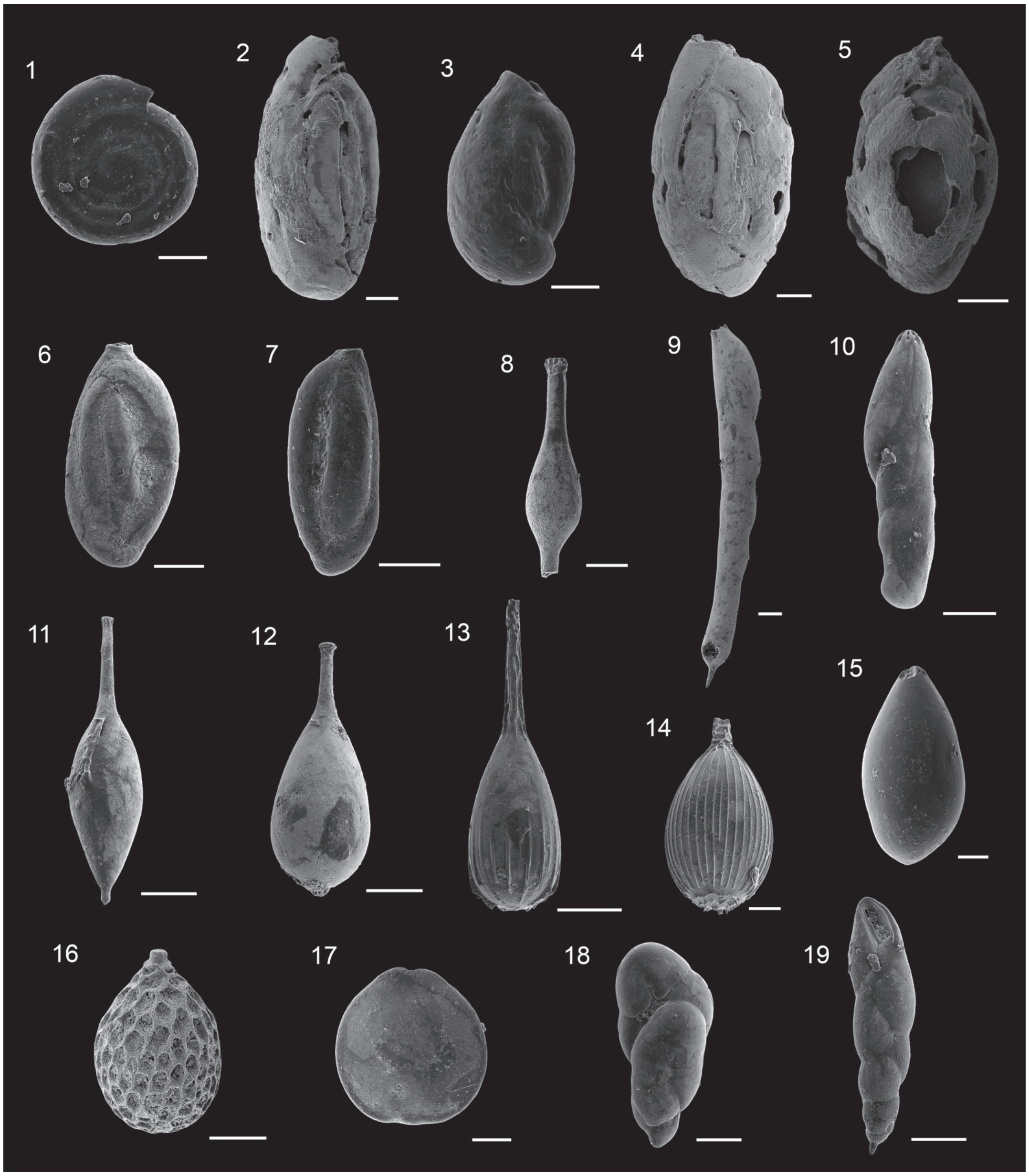

FIGURE 8. 1 *Cornuspira involvens* (Reuss, 1850), side view, sample STZC 21, ABMC 2016/005; 2 *Adelosina longirostra* (d'Orbigny, 1826), four chamber side, sample STZC 32, ABMC 2016/046; 3 *Quinqueloculina parvula* Schlumberger, 1894, four chamber side, sample STZC 21, ABMC 2016/040; 4 *Quinqueloculina seminulum* (Linnaeus, 1758), four chamber side, sample STZC 32, ABMC 2016/007; 5 *Triloculina trigonula* (Lamarck, 1804), peripheral view, sample STZC 32, ABMC 2016/079; 6 *Sigmoilinita distorta* (Phleger and Parker, 1951), side view, sample STZC 28, ABMC 2016/080; 7 *Sigmoilinita distorta* (Phleger and Parker, 1951), side view, sample STZC 33, ABMC 2017/004; 8 *Grigelis guttiferus* (d'Orbigny, 1846), lateral view, sample STZC 13, ABMC 2017/003; 9 *Laevidentalina communis* (d'Orbigny, 1826), lateral view, sample STZC 34, ABMC 2016/042; 10 *Marginulina similis* d'Orbigny, 1846, side view, sample STZC 21, ABMC 2016/026; 11 *Hyalinonetrion clavatum* (d'Orbigny, 1846), lateral view, sample STZC 23, ABMC 2016/084; 12 *Reussoolina laevis* (Montagu, 1803), lateral view, sample STZC 24, ABMC 2016/087; 13 *Lagena semistriata* Williamson, 1848, lateral view, sample STZC 28, ABMC 2016/023; 14 *Lagena striata* (d'Orbigny, 1839), lateral view, sample STZC 33, ABMC 2016/008; 15 *Globulina minuta* (Roemer, 1838), side view, sample STZC 25, ABMC 2016/073; 16 *Favulina hexagona* (Williamson, 1848), lateral view, sample STZC 13, ABMC 2016/059; 17 *Fissurina nummiformis* (Buchner, 1940), lateral view, sample STZC 27, ABMC 2016/039; 18 *Robertina translucens* Cushman and Parker, 1936, lateral view, sample STZC 20, ABMC 2016/088; 19 *Stainforthia complanata* (Egger, 1893), lateral view, sample STZC 26, ABMC 2016/003; Scale bar 1, 3, 14, 15, 17 – 50 μm; 2, 4-13, 16, 18, 19 – 100 μm.

Cornuspira involvens (Reuss, 1850)
Figure 8.1

1850a *Operculina involvens* Reuss: p. 370, pl. 46, fig. 20.

1988 *Cyclogyra involvens* (Reuss); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Cyclogyra involvens* (Reuss); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2012 *Cornuspira involvens* (Reuss); Milker and Schmiedl, p. 44, fig. 12.1.

Distribution and remarks. Rare specimens of this opportunistic, eurybathic, low-oxygen tolerant species (Sen Gupta et al., 2009a, b) have been recorded in the sample STZC 21 (RA=0.29%).

Family SPIROLOCULINIDAE Wiesner, 1920
Genus ADELOSINA d'Orbigny, 1826
Adelosina longirostra (d'Orbigny, 1826)
Figure 8.2

1826 *Quinqueloculina longirostra* d'Orbigny: p. 303, n. 46.

1846 *Quinqueloculina longirostra* d'Orbigny; d'Orbigny, p. 291, pl. 18, figs. 25-27.

1979 *Quinqueloculina longirostra* d'Orbigny; Hageman, p. 104, pl. 9, figs. 3-4.

1988 *Quinqueloculina longirostra* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Quinqueloculina longirostra* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2012 *Adelosina longirostra* (d'Orbigny); Milker and Schmiedl, p. 48, figs. 12.20-21.

Distribution and remarks. The species is common in the infralittoral and upper circalittoral zone of the Mediterranean (Sgarrella and Moncharmont, 1993). A certain morphological variability has been figured by Hageman (1979).

Very rare at La Starza; few tests are present in the sample STZC 32 (RA=0.51%). In the sample STZA 2 the assemblage consists of a single specimen of *A. longirostra*.

Family HAUERINIDAE Schwager, 1876
Subfamily HAUERININAE Schwager, 1876
Genus QUINQUELOCULINA d'Orbigny, 1826
Quinqueloculina parvula Schlumberger, 1894
Figure 8.3

1894 *Quinqueloculina parvula* Schlumberger: p. 255, text-fig. 1, pl. 3, figs. 8-9.

1988 *Quinqueloculina parvula* Schlumberger; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Quinqueloculina parvula* Schlumberger; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2012 *Quinqueloculina parvula* Schlumberger; Milker and Schmiedl, p. 59, figs. 15.25-27.

Distribution and remarks. An infralittoral - upper circalittoral species (Sgarrella and Moncharmont Zei, 1993) tolerating heavy metal pollution (Frontalini and Coccioni, 2011); rare individuals have been found in two samples of the Section C.

Quinqueloculina pygmaea Reuss, 1850

1850a *Quinqueloculina pygmaea* Reuss: p. 384. pl. 50, fig. 3.

1993 *Quinqueloculina pygmaea* Reuss; Sgarrella and Moncharmont Zei, p. 174, pl. 7, fig. 2.

Distribution and remarks. An eurybathic species (Szarek, 2001; Enge et al., 2012) more frequent in infralittoral - upper circalittoral waters (Sgarrella and Moncharmont Zei, 1993). Few tests of *Q. pygmaea* occur in two samples of the Section C (STZC 29 and STZC 32).

Quinqueloculina seminulum (Linnaeus, 1758)
Figure 8.4

1758 *Serpula seminulum* Linnaeus: p. 786.

1988 *Quinqueloculina seminulum* (Linnaeus); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Quinqueloculina seminulum* (Linnaeus); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2003 *Quinqueloculina seminulum* (Linnaeus); Murray, p. 17, figs. 4.11-4.12.

2012 *Quinqueloculina seminula* (Linnaeus); Milker and Schmiedl, p. 59, figs. 15.30-31.

Distribution and remarks. An opportunistic (Langlet et al., 2014) eurybathic (Szarek, 2001; Enge et al., 2012) species, common in marginal, infralittoral and upper circalittoral zone (Murray, 2006; Sen Gupta et al., 2009b). Rare specimens are present in the samples STZC 30 and STZC 32.

Subfamily MILIOLINELLINAE Vella, 1957
Genus TRILOCULINA d'Orbigny, 1826
Triloculina trigonula (Lamarck, 1804)
Figure 8.5

1804 *Miliolites trigonula* Lamarck: p. 351, pl. 17, figs. 4a-c.

2012 *Triloculina trigonula* (Lamarck); Debenay, pp. 138, 278.

Distribution and remarks. An eurybathic species (Szarek, 2001; Sen Gupta et al., 2009b), preferring infralittoral and upper circalittoral zone (Oflaz, 2006). Very rare at La Starza, it is present only in the sample STZC 32 with RA=1.54%.

Subfamily SIGMOILINITINAE ?uczkowska, 1974
Genus SIGMOILINITA Seiglie, 1965
Sigmoilinita distorta (Phleger and Parker, 1951)
Figure 8.6-7

1951 *Sigmoilina distorta* Phleger and Parker: p. 8, pl. 4, figs. 3-5.

1988 *Sigmoilina distorta* Phleger and Parker; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Sigmoilina distorta* Phleger and Parker; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2012 *Sigmoilinita distorta* (Phleger and Parker); Milker and Schmiedl, p. 69, figs. 18.3-4.

Distribution and remarks. An eurybathic species (Sen Gupta et al., 2009b) uncommon in the infralittoral zone (Sgarrella and Moncharmont, 1993; Aiello, Barra and Parisi, pers. obs.). Rare at La Starza, it is present in two samples of Section C.

Suborder LAGENINA Delage and Herouard, 1896
Family NODOSARIIDAE Ehrenberg, 1838
Subfamily NODOSARIINEA Ehrenberg, 1838
Genus GRIGELIS Mikhalevich, 1981
Grigelis guttiferus (d'Orbigny, 1846)
Figure 8.8

1846 *Dentalina guttifera* d'Orbigny: p. 49, pl. 2, figs. 11, 13.

1994 *Grigelis guttiferus* (d'Orbigny); Loeblich and Tappan, p. 64.

2012 *Dentalina guttifera* d'Orbigny; Milker and Schmiedl, p. 72, figs. 18.13.

Distribution and remarks. The species, generally occurring in bathyal muds (Sgarrella and Moncharmont-Zei, 1993), is very rare at La Starza, being present only in the sample STZC 13 (RA=0.42%).

Genus LAEVIDENTALINA Loeblich and Tappan, 1986
Laevidentalina communis (d'Orbigny, 1826)
Figure 8.9

1826 *Nodosaria* (*Dentalina*) *communis* d'Orbigny: p. 254, n. 35.

2012 *Laevidentalina communis* (d'Orbigny); Debenay, pp. 165, 284.

Distribution and remarks. Few specimens of *Laevidentalina communis,* a species mainly recorded in bathyal environment (Sgarrella and Moncharmont, 1993; Debenay, 2012), occur in the sample STZC 34.

Family VAGINULIDAE Reuss, 1860
Subfamily LENTICULININAE Chapman, Parr and Collins, 1934
Genus NEOLENTICULINA McCulloch, 1977
Neolenticulina peregrina (Schwager, 1866)

1866 *Cristellaria peregrina* Schwager: p. 245, pl. 7, fig. 8.

2012 *Neolenticulina peregrina* (Schwager); Milker and Schmiedl, p. 73, figs. 18.21.

Distribution and remarks. An eurybathic species, mainly circalittoral and bathyal (Szarek, 2001; Sen Gupta et al., 2009b), very rare at La Starza. It is present only in the sample STZC 34.

Subfamily MARGINULININAE Wedekind, 1937
Genus AMPHICORYNA Schlumberger, 1881
Amphicoryna scalaris (Batsch, 1791)

1791 *Nautilus (Orthoceras) scalaris* Batsch: pp. 1, 4, pl. 2, figs. 4a-b.

1988 *Amphicoryna scalaris* (Batsch); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Amphicoryna scalaris* (Batsch); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2012 *Amphicoryna scalaris* (Batsch); Milker and Schmiedl, p. 73, figs. 18.22-25.

Distribution and remarks. Rare and poorly preserved specimens of this eurybathic (Sgarrella and Moncharmont-Zei, 1993), stress tolerant (Mojtahid et al., 2006) species, have been recorded in two samples (STZC 18 and STZC 34).

Genus MARGINULINA d'Orbigny, 1826
Marginulina similis d'Orbigny, 1846
Figure 8.10

1846 *Marginulina similis* d'Orbigny, p. 69, pl. 3, figs. 15-16.

1985 *Marginulina similis* d'Orbigny; Papp and Schmid, p. 37, pl. 21, figs 10-12.

1988 *Marginulina glabra* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Marginulina glabra* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.

Distribution and remarks. A lower circalittoral to middle bathyal species (Sgarrella and Moncharmont Zei, 1993; Szarek, 2001; as *M. glabra*), present exclusively in the sample STZC 21 (RA=0.58%).

Family LAGENIDAE Reuss, 1862
Genus HYALINONETRION Patterson and Richardson, 1987
Hyalinonetrion clavatum (d'Orbigny, 1846)
Figure 8.11

1846 *Oolina clavata* d'Orbigny: p. 24, pl. 1, figs. 2-3.

1940 *Lagena clavata* (d'Orbigny); Buchner, p. 416, pl. 2, figs. 28-30.

1988 *Lagena clavata* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Lagena clavata* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

1998 *Hyalinonetrion clavatum* (d'Orbigny); Cicha, Rögl, Rupp and Ctyroka, p. 108, pl. 27, fig. 6.

Distribution and remarks. An accessory species, recorded in infralittoral and upper circalittoral environment (Sgarrella and Moncharmont Zei, 1993; Debenay et al., 2001b), present both in Section C and in Section B. RA ranges from 0.16% to 0.99%.

Genus LAGENA Walker and Jacob, 1798
Lagena semistriata Williamson, 1848
Figure 8.13

1848 *Lagena striata* (Montagu) var. ß, *semistriata* Williamson: p. 14, pl. 1, figs. 9-10.

1988 *Lagena semistriata* Williamson; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Lagena semistriata* Williamson; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

1940 *Lagena laevis* (Montagu) forma *semistriata* (Williamson); Buchner, pl. 3, figs. 39-43.

1993 *Lagena semistriata* Williamson; Sgarrella and Moncharmont Zei, p. 198, pl. 12, fig. 1.

Distribution and remarks. A shelf species (Sgarrella and Moncharmont Zei, 1993; Szarek, 2001), present at La Starza with rare and scattered individuals.

Lagena striata (d'Orbigny, 1839)
Figure 8.14

1839c *Oolina striata* d'Orbigny: p. 21, pl. 5, fig. 12.

1940 *Lagena striata* (d'Orbigny); Buchner, p. 424, pl. 4, figs. 54-61.

2012 *Lagena striata* (d'Orbigny); Milker and Schmiedl, p. 75, fig. 18.33.

Distribution and remarks. This eurybathic species (Szarek et al., 2001; Sen Gupta et al., 2009b) is rare in the La Starza deposits, showing RA values not exceeding 0.66%.

Genus PROCEROLAGENA Puri, 1954
Procerolagena gracilis (Williamson, 1848)

1848 *Lagena gracilis* Williamson: p. 13, pl. 1, fig. 5.

2009a *Procerolagena gracilis* (Williamson); Sen Gupta, Lobegeier and Smith, p. 58, pl. 135, figs. 1-6.

Distribution and remarks. A very rare species, recorded in the lower circalittoral and bathyal zone (Sen Gupta, 2009b), present at La Starza only in the sample STZC 28 (RA=0.34%).

Genus REUSSOOLINA Colom, 1956
Reussoolina laevis (Montagu, 1803)
Figure 8.12

1803 *Vermiculum Laeve* Montagu: p. 524.

1940 *Lagena laevis* (Montagu) *forma laevis* (Montagu); Buchner, pl. 3, figs. 34-36.

1993 *Lagena laevis* (Montagu); Sgarrella and Moncharmont Zei, p. 198, pl. 11, fig. 14.

1994 *Reussoolina laevis* d'Orbigny; Loeblich and Tappan, p. 81, pl. 144, figs. 13-14.

Distribution and remarks. An eurybathic (Sgarrella and Moncharmont Zei, 1993; Sen Gupta, 2009b) species, occurring at La Starza with low RA values (0.16%-0.99%) both in the Section C and in the Section B.

Family POLYMORPHINIDAE d'Orbigny, 1839
Subfamily POLYMORPHININAE d'Orbigny, 1839
Genus GLOBULINA d'Orbigny, 1839
Globulina minuta (Roemer, 1838)
Figure 8.15

1838a *Polymorphina minuta* Roemer: p. 386, pl. 3, figs. 35a-b.

1930 *Globulina minuta* (Roemer); Cushman and Ozawa, pp. 83-84, pl. 20, figs. 3-4.

1971 *Globulina minuta* (Roemer); Gabel, pl. 11, figs. 28-29.

Distribution and remarks. An infralittoral and upper circalittoral species (Sgarrella and Moncharmont, 1993) present with few specimens in section C, with RA ranging from 0.29 to 1.74%.

Family ELLPISOLAGENIDAE Silvestri, 1923
Subfamily OOLININAE Loeblich and Tappan, 1961
Genus FAVULINA Patterson and Richardson, 1987
Favulina hexagona (Williamson, 1848)
Figure 8.16

1848 *Entesolenia squamosa* (Montagu) var. ? *hexagona* Williamson: p. 20, pl. 2, fig. 23 pl. 5, fig. 63.

2012 *Favulina hexagona* (Williamson); Milker and Schmiedl, p. 77, figs. 19.4.

Distribution and remarks. An eurybathic species (Sen Gupta et al., 2009b) recorded, with few specimens, in two samples of the Section C (STZC 13 and STZC 33).

Subfamily ELLIPSOLAGENINAE Silvestri, 1923
Genus FISSURINA Reuss, 1850
Fissurina nummiformis (Buchner, 1940)
Figure 8.17

1940 *Lagena nummiformis* Buchner: p. 457, pl. 8, figs. 135-138.

1993 *Fissurina nummiformis* (Buchner); Sgarrella and Moncharmont-Zei, p. 202.

Distribution and remarks. A circalittoral - upper bathyal species (Buchner, 1940; Sgarrella and Moncharmont-Zei, 1993), present only in the in sample STZC 27 (RA=0.58%).

Family GLANDULINIDAE Reuss, 1860
Genus GLANDULINA d'Orbigny, 1839
Glandulina laevigata (d'Orbigny, 1826)

1826 *Nodosaria laevigata* d'Orbigny: p. 252, pl. 10, figs. 1-3.

1988 *Glandulina laevigata* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Glandulina laevigata* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2012 *Glandulina laevigata* (d'Orbigny); Debenay, pp. 164, 296.

Distribution and remarks. An infra-circalittoral (Szarek, 2001; Debenay, 2012), subordinately bathyal (Sgarrella and Moncharmont Zei, 1993) species, rare at La Starza. It is recorded in two samples of the section C (STZC 30 and STZC 34).

Family CERATOBULIMINIDAE Cushman, 1927
Subfamily CERATOBULIMININAE Cushman, 1927
Genus LAMARCKINA Berthelin, 1881
Lamarckina scabra (Brady, 1884)

1884 *Pulvinulina oblonga* (Williamson) var. *scabra* Brady: p. 689, pl. 106, fig. 8.

2005 *Lamarckina scabra* (Brady); Debenay, Millet and Angelidis, pl. 3, figs. 1.24-25.

Distribution and remarks. A shelf species (Szarek, 2001; Sen Gupta et al., 2009b; Debenay, 2012), very rare at La Starza. Few individuals are present only in the sample STZC 34.

Family ROBERTINIDAE Reuss, 1850
Subfamily ALLIATININAE McGowran, 1966
Genus ROBERTINA d'Orbigny, 1846
Robertina translucens Cushman and Parker, 1936
Figure 8.18

1936 *Robertina translucens* Cushman and Parker: p. 99, pl. 16, figs. 8a-b.

2012 *Robertina translucens* Cushman and Parker; Milker and Schmiedl, p. 80, figs. 19.17-18.

Distribution and remarks. A circalittoral-abyssal species very rare at depth lesser than 60 m (Sgarrella and Moncharmont Zei, 1993). It is present at La Starza with low RA (0.19% to 0.42%) in four samples of the Section C.

Suborder ROTALIINA Delage and Herouard, 1896
Family BOLIVINIDAE Glaessner, 1937
Genus BOLIVINA d'Orbigny, 1839

Bolivina catanensis Seguenza, 1862
Figure 9.6

1862 *Bolivina catanensis* Seguenza: pp. 113, 125, pl. 2, fig. 3.

1988 *Bolivina catanensis* Seguenza; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina catanensis* Seguenza; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.

1993 *Bolivina catanensis* Seguenza; Sgarrella and Moncharmont-Zei, p. 208, pl. 14, figs. 4-5.

Distribution and remarks. *Bolivina catanensis* is present in the infralittoral zone, showing its optimum in circalittoral and upper bathyal waters with moderate oxygen depletion (Sgarrella and Moncharmont-Zei, 1993; Stefanelli and Capotondi, 2008). Rare in the La Starza sediments, the species occurs in two samples (STZC 25 and STZC 34) of the Section C.

Bolivina cistina Cushman, 1936

1936 *Bolivina cistina* Cushman: p. 55, pl. 8, fig. 4.

1990 *Bolivina cistina* Cushman; Hasegawa, Sprovieri and Poluzzi, pl. 3, figs. 1-2.

2012 *Bolivina cistina* Cushman; Milker and Schmiedl, p. 80, figs. 19.19-20.

Distribution and remarks. A shelf (Milker and Schmiedl, 2012) species, very rare at La Starza, being present only in the sample STZC 33.

Bolivina lowmani Phleger and Parker, 1951
Figure 9.7

1951 *Bolivina lowmani* Phleger and Parker: p. 13, pl. 6, figs. 20-21.

1981 *Brizalina lowmani* (Phleger and Parker); Poag, p. 46, pl. 25, fig. 3; pl. 26, figs. 3a-c.

1988 *Bolivina lowmani* Phleger and Parker; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina lowmani* Phleger and Parker; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2009a *Bolivina lowmani* Phleger and Parker; Sen Gupta, Lobegeier and Smith, p. 67, pl. 20, figs. 1-3.

Distribution and remarks. An eurybathic species (Sen Gupta et al., 2009b), dominant in high organic flux, low-oxygen, stressed environment (Vilela et al., 2004). It occurs in 13 samples of the section C (ranging from 0.96% to 5.14%) and in the samples STZB 5 (1.27%) and STZB 6 (0.31%).

Bolivina pseudoplicata Heron-Allen and Earland, 1930
Figure 9.1

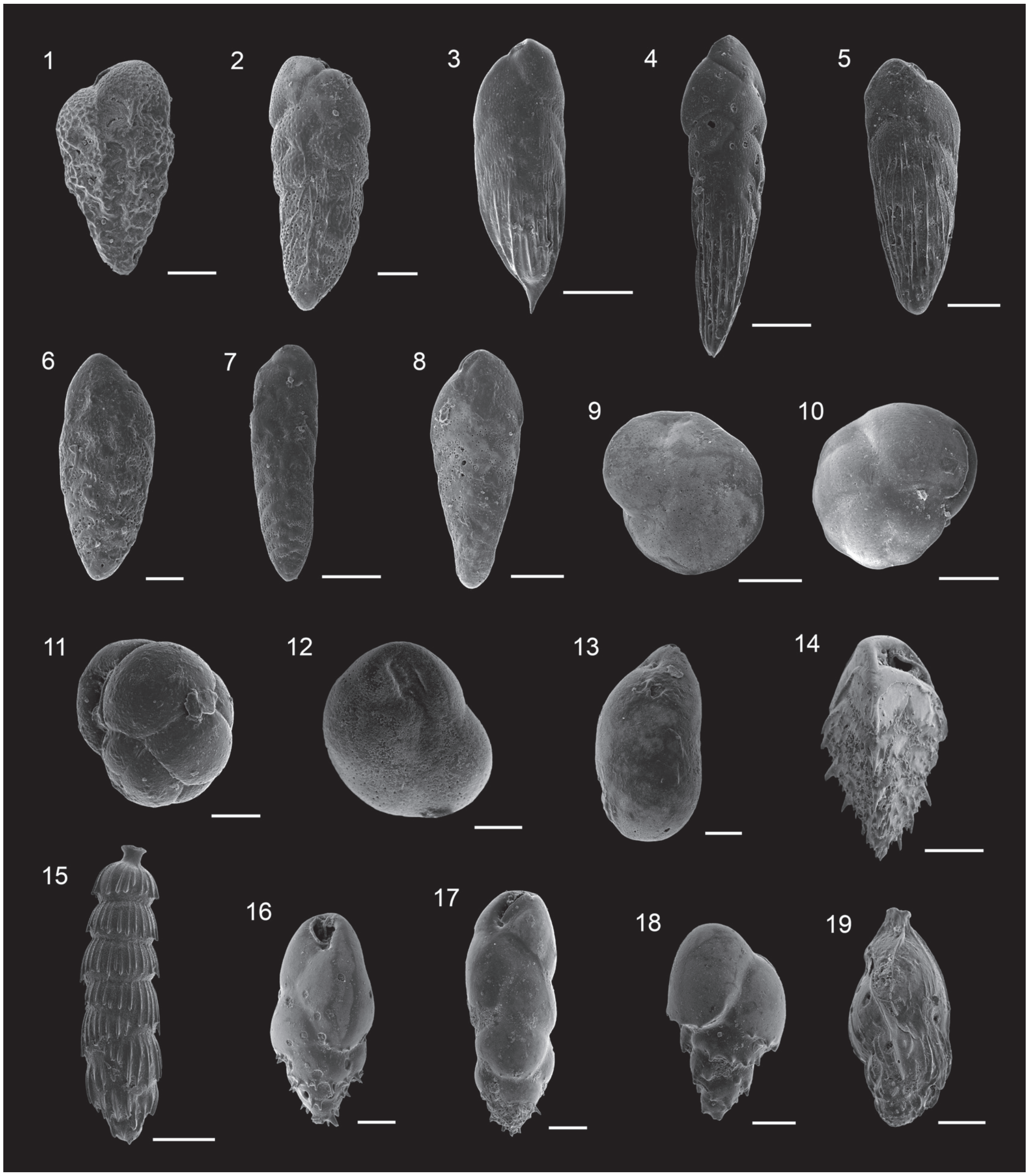

FIGURE 9. 1 *Bolivina pseudoplicata* Heron-Allen and Earland, 1930, lateral view, sample STZC 18, ABMC 2016/047; 2 *Bolivina variabilis* (Williamson, 1858), lateral view, sample STZC 18, ABMC 2016/049; 3 *Brizalina aenariensis* Costa, 1856, lateral view, sample STZC 29 ABMC 2016/081; 4 *Brizalina aenariensis* Costa, 1856, lateral view, sample STZC 31, ABMC 2017/005; 5 *Brizalina striatula* Cushman, 1922, lateral view, sample STZB 6, ABMC 2017/007; 6 *Bolivina catanensis* Seguenza, 1862, lateral view, sample STZC 25, ABMC 2016/074; 7 *Bolivina lowmani* Phleger and Parker, 1951, lateral view, sample STZC 29, ABMC 2016/033; 8 *Brizalina spathulata* (Williamson, 1858), lateral view, sample STZC 27, ABMC 2016/063; 9 *Cassidulina carinata* Silvestri, 1896, side view, sample STZC 21, ABMC 2016/028; 10 *Cassidulina carinata* Silvestri, 1896, apertural side, sample STZC 31, ABMC 2017/095; 11 *Cassidulina obtusa* Williamson, 1858, apertural side, sample STZC 19, ABMC 2016/032; 12 *Globocassidulina subglobosa* (Brady, 1881), apertural side, sample STZC 33, ABMC 2017/088; 13 *Evolvocassidulina bradyi* (Norman, 1881), lateral view, sample STZC 24, ABMC 2016/037; 14 *Reussella spinulosa* (Reuss, 1850), lateral view, sample STZC 23, ABMC 2016/085; 15 *Rectuvigerina phlegeri* Le Calvez, 1959, lateral view, sample STZC 29, ABMC 2016/022; 16 *Bulimina aculeata* d'Orbigny, 1826, lateral view, sample STZC 20, ABMC 2016/041; 17 *Bulimina elongata* d'Orbigny, 1846, lateral view, sample STZC 18, ABMC 2016/010; 18 *Bulimina marginata* d'Orbigny, 1826, lateral view, sample STZC 15, ABMC 2016/020; 19 *Trifarina angulosa* (Williamson, 1858), lateral view, sample STZC 33, ABMC 2016/004; Scale bar 1, 2, 6, 11-13, 16-19 – 50 µm; 3-5, 7-10, 14, 15 – 100 µm.

1930 *Bolivina pseudoplicata* Heron-Allen and Earland: pp. 81-82, pl. 3, figs. 36-40.

1988 *Bolivina pseudoplicata* Heron-Allen and Earland; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina pseudoplicata* Heron-Allen and Earland; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2003 *Bolivina pseudoplicata* Heron-Allen and Earland; Murray, p. 19, fig. 5.17.

Distribution and remarks. *Bolivina pseudoplicata* is an eurybathic, dysoxic tolerant (Murray, 1991; Langlet et al., 2014) species, occurring in the upper part of the Section C and in STZB 6 with rare specimens.

Bolivina variabilis (Williamson, 1858)
Figure 9.2

1858 *Textularia variabilis* Williamson: p. 76, pl. 6, figs. 162-163.

1988 *Bolivina variabilis* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina variabilis* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2012 *Bolivina variabilis* (Williamson); Milker and Schmiedl, p. 81, figs. 19.25-26.

Distribution and remarks. A shelf species (Sen Gupta et al., 2009b) stress tolerant (Frontalini and Coccioni, 2011) and low-oxygen tolerant (Schmiedl et al., 2003; Kuhnt et al., 2007). It occurs with rare individuals in six samples of the Section C and in the sample STZB 6.

Genus BRIZALINA Costa, 1856
Brizalina aenariensis Costa, 1856
Figure 9.3-4

1856 *Brizalina aenariensis* Costa: p. 297, pl. 15, fig. 1a.

1988 *Bolivina aenariensis* (Costa); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina aenariensis* (Costa); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

1992 *Bolivina aenariensis* (Costa); Sgarrella, pp. 317-323, pl. 1, figs. 1-13; pl. 2, figs. 1-11.

1996 *Brizalina aenariensis* Costa; Revets, p. 9, pl. 4, figs. 5-8.

Distribution and remarks. The species, occurring in Recent waters from the middle-lower infralittoral to upper bathyal zone (Sgarrella and Moncharmont-Zei, 1993; Frezza and Carboni, 2009) is not frequent at La Starza, with RA ranging from 0.16% to 0.86%.

Brizalina spathulata (Williamson, 1858)
Figure 9.8

1858 *Textularia variabilis* var. *spathulata* Williamson: p. 76, pl. 6, figs. 164-165.

1988 *Bolivina spathulata* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina spathulata* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 480.

2012 *Brizalina spathulata* (Williamson); Milker and Schmiedl, p. 82, figs. 20.1-2.

Distribution and remarks. A typical low oxygen tolerant species (Stefanelli, 2004), living in infralittoral waters and recorded in the Section C with rare specimens.

Brizalina striatula (Cushman, 1922)
Figure 9.5

1922 *Bolivina striatula* Cushman: p. 27, pl. 3, fig. 10.

1988 *Bolivina striatula* Cushman; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bolivina striatula* Cushman; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.

2012 *Brizalina striatula* (Cushman); Milker and Schmiedl, p. 82, fig. 20.3.

Distribution and remarks. A low-oxygen, high organic matter, low-salinity tolerant species, reported mainly from marginal to circalittoral environment, preferring coastal lagoons and estuaries (Eichler et al., 2003; Sen Gupta et al., 2009b; Debenay, 2012). Present at La Starza with generally low RA values (0.16%-6.45%) in the majority of the fossiliferous samples.

Family CASSIDULINIDAE d'Orbigny, 1839
Subfamily CASSIDULININAE d'Orbigny, 1839
Genus CASSIDULINA d'Orbigny, 1826
Cassidulina carinata Silvestri, 1896
Figure 9.9-10

1896 *Cassidulina laevigata* d'Orbigny var. *carinata* Silvestri: p. 104, pl. 2, figs. 10 a-c.

1988 *Cassidulina laevigata carinata* Silvestri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Cassidulina laevigata carinata* Silvestri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2009a *Cassidulina carinata* Silvestri; Sen Gupta, Lobegeier and Smith, p. 72, pls. 33-34.

Distribution and remarks. *Cassidulina carinata* is an opportunistic circalittoral-bathyal species that tolerates suboxic waters (Jorissen et al., 2007). This species is present at La Starza in the majority of the fossiliferous samples (RA=0.21%-5.53%).

Cassidulina obtusa Williamson, 1858
Figure 9.11

1858 *Cassidulina obtusa* Williamson: p. 69, pl. 6, figs. 143-144.

1988 *Cassidulina crassa* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Cassidulina crassa* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 481.

2009a *Cassidulina obtusa* Williamson; Sen Gupta, Lobegeier and Smith, pp. 73-74, pl. 36, figs. 1-5.

2012 *Cassidulina obtusa* Williamson; Milker and Schmiedl, pp. 84-85, figs. 20.7-8.

Distribution and remarks. The species has been frequently reported as *Cassidulina crassa* d'Orbigny, 1839c (v. Sen Gupta et al., 2009a; Milker and Schmiedl, 2012). This species prefers high oxygen concentrations (De Rijk et al., 2000; Kuhnt et al., 2007, as *C. crassa*) in the lower circalittoral-bathyal zone (Murray, 2003; Sen Gupta et al., 2009a; Milker and Schmiedl, 2012). Rare individuals have been recorded in four samples of the Section C and in STZB 6.

EVOLVOCASSIDULINA Eade, 1967
Evolvocassidulina bradyi (Norman, 1881)
Figure 9.13

1881 *Cassidulina bradyi* Norman (in Brady, 1881): p. 59.

1983 *Evolvocassidulina bradyi* (Norman); Nomura, p. 48, pl. 4, figs. 3a-b.

2012 *Cassidulinoides bradyi* (Norman); Milker and Schmiedl, p. 85, fig. 20.9.

Distribution and remarks. Very rare specimens of this shelf-bathyal (Sen Gupta et al., 2009b) species, frequently assigned to the genus *Cassidulinoides*, have been collected from the sample STZC 24.

Genus GLOBOCASSIDULINA Voloshinova, 1960
Globocassidulina subglobosa (Brady, 1881)
Figure 9.12

1881 *Cassidulina subglobosa* Brady: p. 60.

1988 *Globocassidulina subglobosa* (Brady); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Globocassidulina subglobosa* (Brady); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2009a *Globocassidulina subglobosa* (Brady); Sen Gupta, Lobegeier and Smith, pp. 74-75, pl. 68, figs. 1-4.

Distribution and remarks. An eurybathic species, mostly circalittoral and bathyal, living in organic rich sediments, capable of tolerating dysoxic waters (Jorissen et al., 2007; Sen Gupta et al., 2009a). Uncommon at La Starza, it is present in the Section C showing RA range from 0.27% to 1.43%.

Family STAINFORTHIIDAE Reiss, 1963
Genus STAINFORTHIA Hofker, 1956
Stainforthia complanata (Egger, 1893)
Figure 8.19

1893 *Virgulina schreibersiana* Czjzek var. *complanata* Egger: pp. 292-293, pl. 8, figs. 91-92.

1988 *Stainforthia complanata* (Egger); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Stainforthia complanata* (Egger); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2009a *Stainforthia complanata* (Egger); Sen Gupta, Lobegeier and Smith, p. 76, pl. 171, figs. 1-5.

Distribution and remarks. An eurybathic species (Sen Gupta et al., 2009b), occurring mostly in lower infralittoral and upper circalittoral zone (Sgarrella and Moncharmont, 1993). In the La Starza outcrops *S. complanata* has been recorded in the majority of the fossiliferous samples, with low abundance values (RA=0.18%-2.29%).

Family SIPHOGENERINOIDIDAE Saidova, 1981
Subfamily TUBULOGENERININAE Saidova, 1981
Genus RECTUVIGERINA Mathews, 1945
Rectuvigerina phlegeri Le Calvez, 1959
Figure 9.15

1959 *Rectuvigerina phlegeri* Le Calvez in Berthois and Le Calvez: p. 363, pl. 1, fig. 11.

1988 *Rectuvigerina phlegeri* Le Calvez; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Rectuvigerina phlegeri* Le Calvez; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482, pl. 2, fig. 2.

2012 *Rectuvigerina phlegeri* Le Calvez; Milker and Schmiedl, p. 86, fig. 20.18.

Distribution and remarks. *Rectuvigerina phlegeri* is a stress tolerant, opportunistic shelf species, common in eutrophic, hypoxic environments (Diz and Francés, 2008; Goineau et al., 2011; Barras et al., 2014). Not rare in the Section C, with RA ranging from 0.19% to 7.87%.

FAMILY BULIMINIDAE Jones, 1875
Genus BULIMINA d'Orbigny, 1826
Bulimina aculeata d'Orbigny, 1826
Figure 9.16

1826 *Bulimina aculeata* d'Orbigny: p. 269, no. 7.

1988 *Bulimina aculeata* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bulimina aculeata* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2012 *Bulimina aculeata* d'Orbigny; Milker and Schmiedl, p. 87, fig. 20.19.

Distribution and remarks. *Bulimina aculeata* is an opportunistic species that tolerates low-oxygen environment, with degraded organic matter (Schmiedl et al., 2000, and references therein). It occurs from the infralittoral to the bathyal zone, showing its optimum within the circalittoral zone (40-130 m; Jorissen, 1988; v. Avnaim-Katav et al., 2013 for extensive references). Relatively common in the La Starza sediments (RA range: 0.51%-5.10%).

Bulimina elongata d'Orbigny, 1846
Figure 9.17

1846 *Bulimina elongata* d'Orbigny: p. 187, pl. 11, figs. 19-20.

1988 *Bulimina elongata* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bulimina elongata* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482, pl. 2, figs. 3-4.

2012 *Bulimina elongata* d'Orbigny; Milker and Schmiedl, p. 88, fig. 20.21.

Distribution and remarks. The species occurs in shelf Mediterranean areas, on fine grained sediment bottom. Mainly recorded within the infralittoral zone, it prefers low energy-low oxygen waters, with high organic matter waters (Jorissen, 1988; Eichler et al., 2003). *Bulimina elongata* is one of the characteristic species of the La Starza assemblages (RA range: 1.02%-10.34%).

Bulimina marginata d'Orbigny, 1826
Figure 9.18

1826 *Bulimina marginata* d'Orbigny: p. 269, pl. 12, figs. 10-12.

1988 *Bulimina marginata* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Bulimina marginata* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2012 *Bulimina marginata* d'Orbigny; Milker and Schmiedl, p. 88, fig. 20.23.

Distribution and remarks. *Bulimina marginata* is recorded from the infralittoral to the bathyal zone, and shows preference for circalittoral organic rich muds. It is tolerant to low oxygen bottom waters (Sen Gupta et al., 2009b; Davidsson, 2014). This accessory species occurs in five samples of the section C, with RA ranging from 0.21% to 3.39%.

FAMILY UVIGERINIDAE Haeckel, 1894
Subfamily ANGULOGERININAE Galloway, 1933
Genus TRIFARINA Cushman, 1923
Trifarina angulosa (Williamson, 1858)
Figure 9.19

1858 *Uvigerina angulosa* Williamson: p. 67, pl. 5, fig. 140.

1988 *Trifarina angulosa* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Trifarina angulosa* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2010 *Trifarina angulosa* (Williamson); Hayward, Grenfell, Sabaa, Neil and Buzas, p. 204, pl. 21, figs. 12-15.

Distribution and remarks. *Trifarina angulosa* is typical of lower circalittoral-bathyal environment, preferring well oxygenated, high energy bottoms, with sustained food input (Hayward et al., 2002). This accessory species is present in 11 samples of Section C and in the sample STZB 5.

Family REUSSELLIDAE Cushman, 1933
Genus REUSSELLA Galloway, 1933
Reussella spinulosa (Reuss, 1850)
Figure 9.14

1850a *Verneuilina spinulosa* Reuss: p. 374, pl. 47, fig. 12.

1964 *Reussella spinulosa* (Reuss); Rodriquez, p. 115, pl. 6, fig. II.7.

1988 *Reussella spinulosa* (Reuss); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Reussella spinulosa* (Reuss); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

1998 *Reussella spinulosa* (Reuss); Cicha, Rögl, Rupp and Ctyroka, p. 124, pl. 54, figs. 16-17.

2012 *Reussella spinulosa* (Reuss); Milker and Schmiedl, p. 92, figs. 21.6-7.

Distribution and remarks. A phytophilous shelf species (Szarek, 2001) common on sandy bottoms in the upper circalittoral zone of the Mediterranean (Jorissen, 1987; Barmawidjaja et al., 1995;

Avnaim-Katav et al., 2015). Present in the majority of the fossiliferous samples at La Starza, with RA ranging from 0.46% to 11.94%.

Family FURSENKOINIDAE Loeblich and Tappan, 1961
Fursenkoina subacuta (d'Orbigny, 1852)
Figure 10.1

1846 *Polymorphina acuta* d'Orbigny: p. 234, pl. 13, figs. 4-5; pl. 14, figs. 5-7 (non *Polymorphina acuta* Roemer, 1838).

1852 *Polymorphina subacuta* d'Orbigny: p. 159 (new name).

2012 *Fursenkoina acuta* (d'Orbigny); Milker and Schmiedl, pp. 92-93, figs. 21.10-11.

2017 *Fursenkoina subacuta* (d'Orbigny); Harzhauser, Theobalt, Strauss, Mandic, Carnevale and Piller, pl. 1, fig. 26.

Distribution and remarks. This accessory infra-circalittoral, stress tolerant species, (Sgarrella and Moncharmont-Zei, 1993; Bergin et al., 2006; Avnaim-Katav et al., 2013; as *F. acuta*) is present at La Starza in 16 samples, with low percent values (RA=0.18%-0.66%).

Fursenkoina tenuis (Seguenza, 1862)
Figure 10.2

1862 *Virgulina tenuis* Seguenza: p. 112, pl. 2, fig. 2.

1988 *Fursenkoina tenuis* (Seguenza); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Fursenkoina tenuis* (Seguenza); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 481.

1993 *Fursenkoina tenuis* (Seguenza); Sgarrella and Moncharmont-Zei, p. 236, pl. 23, fig. 12.

Distribution and remarks. A circalittoral, mainly bathyal species, rare in lower infralittoral zone (Sgarrella and Moncharmont-Zei, 1993), present with few specimens in three samples of Section C.

Family BAGGINIDAE Cushman, 1927
Subfamily BAGGININAE Cushman, 1927
Genus CANCRIS de Montfort, 1808
Cancris auricula (Fichtel and Moll, 1798)

1798 *Nautilus auricula* Fichtel and Moll: p. 108, pl. 20, figs. a-f.

2003 *Cancris auricula* (Fichtel and Moll); Murray, p. 19, figs. 6.6-6.7.

Distribution and remarks. Few specimens of this shelf-bathyal species, linked to high organic matter (Altenbach et al., 2003), are present in the sample STZB 5. It tolerates suboxic bottom waters (Jorissen et al., 2007).

Genus VALVULINERIA Cushman, 1926
Valvulineria complanata (d'Orbigny, 1846)
Figure 10.3

1846 *Rosalina complanata* d'Orbigny: p. 175, pl. 10, figs. 13-15.

1988 *Valvulineria bradyana* (Fornasini); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Valvulineria bradyana* (Fornasini); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2012 *Valvulineria complanata* (d'Orbigny); Milker and Schmiedl, pp. 93-94, figs. 10.13-15.

Distribution and remarks. This species has been frequently cited as *Valvulineria bradyana* (Fornasini, 1900) that is a younger synonym of *V. complanata* (Milker and Schmiedl, 2012). It is an opportunistic form, common in high organic matter, low oxygen environment (Goineau et al., 2011). *Valvulineria complanata* is recorded in the shelf - upper bathyal zone, occurring mainly in the upper circalittoral zone (Frezza and Carboni, 2009; Sen Gupta et al., 2009b; Avnaim-Katav et al., 2015). The species occurs, rare, in the upper part of Section C.

Family DISCORBIDAE Ehrenberg, 1838
Genus ROTORBIS Sellier de Civrieux, 1977
Rotorbis auberii (d'Orbigny, 1839)
Figure 10.6

1839a *Rosalina auberii* d'Orbigny: p. 94, pl. 4, figs. 5-8.

1988 *Discorbis mira* Cushman; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Discorbis mira* Cushman; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.

1992 *Rotorbis auberii* (d'Orbigny); Hansen and Revets, p. 175, pl. 1, figs. 1-3, 7.

Distribution and remarks. *Rotorbis auberii* is an infralittoral-circalittoral species frequently cited as *Discorbis mira* Cushman, 1922 (Sgarrella and Moncharmont Zei, 1993). At La Starza is present with few individuals in the samples STZC 15 and STZC 29.

Family ROSALINIDAE Reiss, 1963
Genus GAVELINOPSIS Hofker, 1951
Gavelinopsis praegeri (Heron-Allen and Earland, 1913)
Figure 10.4-5

1913 *Discorbina praegeri* Heron-Allen and Earland: p. 122, pl. 10, figs. 8-10.

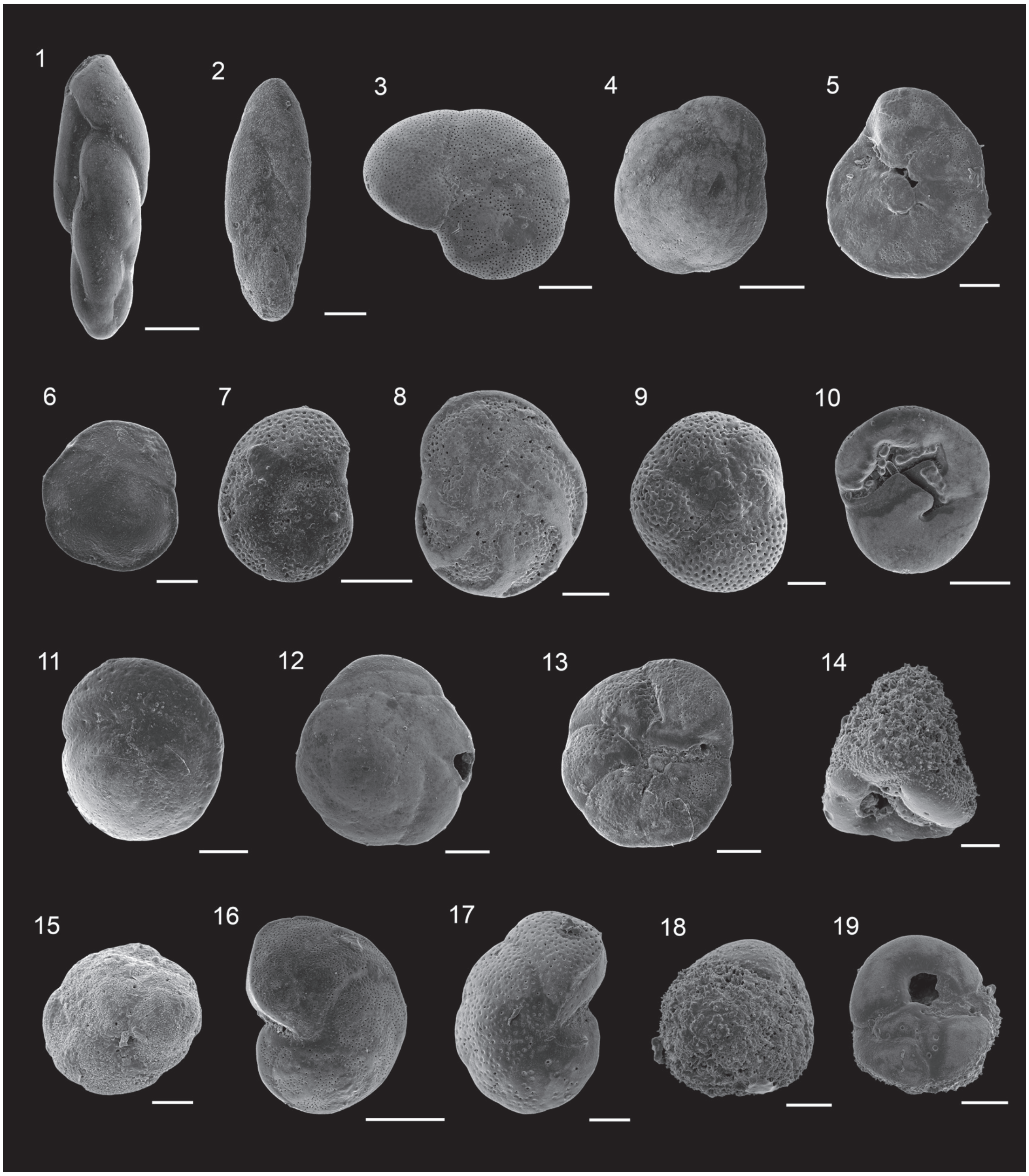

FIGURE 10. 1 *Fursenkoina subacuta* (d'Orbigny, 1852), lateral view, sample STZB 6, ABMC 2016/025; 2 *Fursenkoina tenuis* (Seguenza, 1862), lateral view, sample STZC 22, ABMC 2016/057; 3 *Valvulineria complanata* (d'Orbigny, 1846), spiral side, sample STZC 33, ABMC 2016/009; 4 *Gavelinopsis praegeri* (Heron-Allen and Earland, 1913), spiral side, sample STZC 19, ABMC 2016/082; 5 *Gavelinopsis praegeri* (Heron-Allen and Earland, 1913), umbilical side, sample STZC 19, ABMC 2016/083; 6 *Rotorbis auberii* (d'Orbigny, 1839), spiral side, sample STZC 29, ABMC 2016/069; 7 *Rosalina floridana* (Cushman, 1922), spiral side, sample STZC 31, ABMC 2016/029; 8 *Rosalina macropora* (Hofker, 1951), spiral side, sample STZC 26, ABMC 2016/030; 9 *Rosalina obtusa* d'Orbigny, 1846, spiral side, sample STZC 33, ABMC 2016/090; 10 *Rosalina obtusa* d'Orbigny, 1846, umbilical side, sample STZC 33, ABMC 2016/089; 11 *Tretomphalus concinnus* (Brady, 1884), spiral side, sample STZC 31, ABMC 2016/065; 12 *Epistominella vitrea* Parker, 1953, spiral side, sample STZC 30, ABMC 2016/078; 13 *Epistominella vitrea* Parker, 1953, umbilical side, sample STZC 19, ABMC 2016/070; 14 *Glabratella erecta* (Sidebottom, 1908), side view, sample STZC 28, ABMC 2016/071; 15 *Glabratella hexacamerata* Seiglie and Bermudez, 1965, spiral side, sample STZC 15, ABMC 2016/066; 16 *Discorbinella bertheloti* (d'Orbigny, 1839), spiral side, sample STZC 33, ABCM 2017/031; 17 *Cibicides lobatulus* (Walker and Jacob, 1798), spiral side, sample STZC 19, ABMC 2016/001; 18 *Asterigerinata adriatica* Haake, 1977, spiral side, sample STZC 31, ABMC 2016/011; 19 *Asterigerinata adriatica* Haake, 1977, umbilical side, sample STZC 31, ABMC 2016/012. Scale bar 2, 5, 6, 9-15, 18, 19 – 50 μm; 1, 3, 4, 7, 8, 16, 17 – 100 μm.

1988 *Gavelinopsis praegeri* (Heron-Allen and Earland); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Gavelinopsis praegeri* (Heron-Allen and Earland); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2010 *Gavelinopsis praegeri* (Heron-Allen and Earland); Hayward, Grenfell, Sabaa, Neil and Buzas, p. 230, pl. 31, figs. 14-21.

2012 *Gavelinopsis praegeri* (Heron-Allen and Earland); Milker and Schmiedl, p. 97, figs. 22.3-4.

Distribution and remarks. An eurybathic species (Hayward et al., 2010), recorded in shelf and bathyal environment, very rare in the upper infralittoral zone (Aiello, Barra and Parisi, pers. obs.), epifaunal on hard substrates (Murray, 2006). Not rare in the La Starza assemblages, with RA ranging from 0.32% to 6.94%.

Genus ROSALINA d'Orbigny, 1826
Rosalina floridana (Cushman, 1922)
Figure 10.7

1922 *Discorbis floridana* Cushman: p. 39, pl. 5, figs. 11-12.

1979 *Rosalina floridana* (Cushman); Angell, pl. 1, figs. 1-2.

2012 *Rosalina floridana* (Cushman); Debenay, pp. 211, 310.

Distribution and remarks. An eurybathic (Sen Gupta et al., 2009b) species, mainly recorded in the infralittoral and upper circalittoral zone (Javaux and Scott, 2003; Murray, 2014). It occurs in Section C, mainly in the upper part, with low RA values.

Rosalina macropora (Hofker, 1951)
Figure 10.8

1951 *Discopulvinulina macropora* Hofker: p. 460, figs. 312-313.

1988 *Rosalina bradyi* (Cushman); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Rosalina bradyi* (Cushman); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2012 *Rosalina macropora* (Hofker); Milker and Schmiedl, p. 99, figs. 22.17-18.

Distribution and remarks. A phytal species recorded in the infralittoral and, subordinately, in the circalittoral zone (Sgarrella and Moncharmont-Zei, 1993, as *R. bradyi*; Milker and Schmiedl, 2012). *Rosalina macropora* is present mainly in the upper part of Section C, always rare.

Rosalina obtusa d'Orbigny, 1846
Figure 10.9-10

1846 *Rosalina obtusa* d'Orbigny: p. 179, tab.11, figs. 4-6.

1988 *Rosalina obtusa* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Rosalina obtusa* d'Orbigny; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

1993 *Rosalina obtusa* d'Orbigny; Sgarrella and Moncharmont Zei, p. 219, pl. 17, figs. 9-10.

1998 *Rosalina obtusa* d'Orbigny; Cicha, Rögl, Rupp and Ctyroka, p. 124, pl. 60, figs. 1-3.

Distribution and remarks. *Rosalina obtusa* is a phytophilous species mainly present in infralittoral and upper circalittoral zone (Sgarrella and Moncharmont Zei, 1993). It occurs mainly in the upper part of the Section C (RA from 0.25% to 5.11%).

Genus TRETOMPHALUS Möbius, 1880
Tretomphalus concinnus (Brady, 1884)
Figure 10.11

1884 *Discorbina concinna* Brady: p. 646, pl. 90, fig. 7.

2012 *Tretomphalus concinnus* (Brady); Milker and Schmiedl, p. 99, figs. 22.24-25.

Distribution and remarks. A shelf species (Szarek, 2001; Sen Gupta et al., 2009b) more common in the lower infralittoral and upper circalittoral zone (Sgarrella and Moncharmont Zei, 1993). Present in three samples of the Section C, with low RA values.

Family PSEUDOPARRELLIDAE Voloshinova, 1952
Genus EPISTOMINELLA Husezima and Maruhasi, 1944
Epistominella vitrea Parker, 1953
Figure 10.12-13

1953 *Epistominella vitrea* Parker (in Parker, Phleger and Peirson): p. 9, pl. 4, figs. 34-36, 40, 41.

1988 *Epistominella vitrea* Parker; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Epistominella vitrea* Parker; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.

2009a *Epistominella vitrea* Parker; Sen Gupta, Lobegeier and Smith, p. 91, pl. 60, figs. 1a-c.

Distribution and remarks. An infaunal, opportunistic, eurybathic species common in bathyal environment, tolerating low oxic bottom waters (Jorissen et al., 2007; Margreth et al., 2009; Sen Gupta et al., 2009b). Rare at La Starza, with a RA range of 0.59%-1.74%.

Family GLABRATELLIDAE Loeblich and Tappan, 1964
Genus GLABRATELLA Dorreen, 1948
Glabratella erecta (Sidebottom, 1908)
Figure 10.14

1908 *Discorbina erecta* Sidebottom: p. 16, pl. 5, figs. 6-7.

2012 *Glabratella erecta* (Sidebottom, 1908); Milker and Schmiedl, p. 102, figs. 23.12-13.

Distribution and remarks. *Glabratella erecta* is an infralittoral and upper circalittoral species (Sgarrella and Moncharmont Zei, 1993; Milker and Schmiedl, 2012) very rare at La Starza. Few tests have been found in the sample STZC 28.

Glabratella hexacamerata Seiglie and Bermudez, 1965
Figure 10.15

1965 *Glabratella hexacamerata* Seiglie and Bermudez: p. 31, pl. 1, figs. 6-7.

2012 *Glabratella hexacamerata* Seiglie and Bermudez; Milker and Schmiedl, p. 102, figs. 23.14-15.

Distribution and remarks. Few specimens of this infralittoral and upper circalittoral species (Sen Gupta et al., 2009b; Milker and Schmiedl, 2012) have been recorded in the sample STZC 15.

Family DISCORBINELLIDAE Sigal, 1952
Subfamily DISCORBINELLINAE Sigal, 1952
Genus DISCORBINELLA Cushman and Martin, 1935
Discorbinella bertheloti (d'Orbigny, 1839)
Figure 10.16

1839b *Rosalina bertheloti* d'Orbigny: p. 135, pl. 1, figs. 28-30.

2012 *Discorbinella bertheloti* (d'Orbigny); Milker and Schmiedl, p. 104, figs. 23.29-30.

Distribution and remarks. The species is recorded from infralittoral to middle bathyal waters, on fine grained sediments (Milker et al., 2009; Sen Gupta et al., 2009b). *Discorbinella bertheloti* is present, rare, in the uppermost part of Section C.

Family CIBICIDIDAE Cushman, 1927
Subfamily CIBICIDINAE Cushman, 1927
Genus CIBICIDES de Montfort, 1808
Cibicides lobatulus (Walker and Jacob, 1798)
Figure 10.17

1798 *Nautilus lobatulus* Walker and Jacob: p. 642, pl. 14, fig. 36.

1964 *Cibicides lobatulus* (Walker and Jacob); Rodriquez, p. 116, pl. 6, fig. II.4.

1988 *Cibicides lobatulus* (Walker and Jacob); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Cibicides lobatulus* (Walker and Jacob); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2009 *Cibicides lobatulus* (Walker and Jacob); Schweizer, Pawlowski, Kouwenhoven and van der Zwaan, pp. 124-125, figs. 3.2.d-i; figs. 5a-l.

Distribution and remarks. The species, frequently reported as *Lobatula lobatula*, lives attached on algae or hard substrates in well oxygenated waters (Jorissen et al., 2007). Mainly occurring in infralittoral - upper circalittoral environment (Sgarrella and Moncharmont Zei, 1993), *C. lobatulus* can be considered an eurybathic species (Szarek, 2001; Sen Gupta et al., 2009b). At La Starza section it is present in the main part of the fossiliferous samples, generally with low RA values, ranging from 0.19% to 7.32%.

Family ASTERIGERINATIDAE Reiss, 1963
Genus ASTERIGERINATA Bermudez, 1949
Asterigerinata adriatica Haake, 1977
Figure 10.18-19

1977 *Asterigerinata adriatica* Haake: p. 69, pl. 3, figs. 1-5.

1988 *Asterigerinata adriatica* Haake; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Asterigerinata adriatica* Haake; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 2, figs. 7-8.

2012 *Asterigerinata adriatica* Haake; Milker and Schmiedl, p. 111, figs. 25.7-9.

Distribution and remarks. *Asterigerinata adriatica* is a lower infralittoral - upper bathyal species, not recorded above 24 mbsl (optimum: 50-130 m bsl; Sgarrella and Moncharmont, 1993), showing preference for muddy bottoms (Haake, 1977). It occurs in the majority of the fossiliferous samples of La Starza with RA ranging from 0.51% to 15.14%.

Asterigerinata mamilla (Williamson, 1858)
Figure 11.1-2

1858 *Rotalina mamilla* Williamson: p. 54, pl. 4, figs. 109-111.

1988 *Asterigerinata mamilla* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Asterigerinata mamilla* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 2, figs. 7-8.

2012 *Asterigerinata mamilla* (Williamson); Milker and Schmiedl, p. 111, figs. 25.10-13.

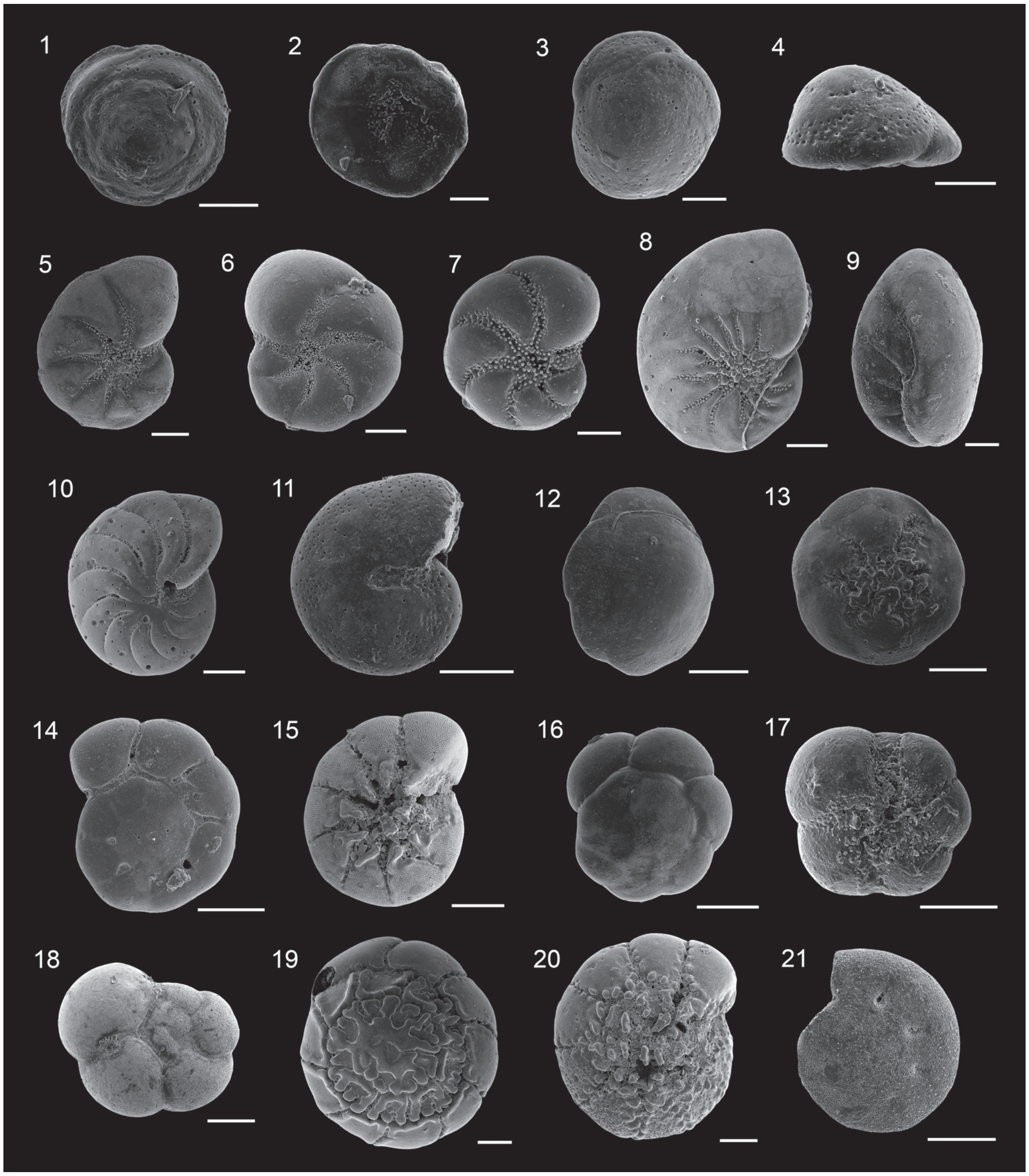

FIGURE 11. 1 *Asterigerinata mamilla* (Williamson, 1858), spiral side, sample STZC 31, ABMC 2016/013; 2 *Asterigerinata mamilla* (Williamson, 1858), umbilical side, sample STZC 31, ABMC 2017/001; 3 *Asterigerinata mariae* Sgarrella, 1990, spiral side, sample STZC 29, ABMC 2016/091; 4 *Asterigerinata mariae* Sgarrella, 1990, oblique peripheral view, sample STZC 18, ABMC 2017/013; 5 *Haynesina depressula* (Walker and Jacob, 1798*),* side view, sample STZC 18, ABMC 2016/036; 6 *Haynesina germanica* (Ehrenberg, 1840), side view, sample STZC 28, ABMC 2016/064; 7 *Haynesina germanica* (Ehrenberg, 1840), spiral side, sample STZC 29, ABMC 2016/055; 8 *Nonion fabum* (Fichtel and Moll, 1798), side view, sample STZC 32, ABMC 2016/054; 9 *Nonionella turgida* (Williamson, 1858), side view, sample STZC 18, ABMC 2016/024; 10 *Astrononion stelligerum* (d'Orbigny, 1839), umbilical side, sample STZC 32, ABMC 2016/043; 11 *Melonis affinis* (Reuss, 1851), side view, sample STZC15, ABMC 2016/018; 12 *Buccella granulata* (Di Napoli Alliata, 1952), spiral side, sample STZC 29, ABMC 2016/014; 13 *Buccella granulata* (Di Napoli Alliata, 1952), umbilical side, sample STZC 29, ABMC 2016/015; 14 *Ammonia aberdoveyensis* Haynes, 1973 rounded form, spiral side, sample STZC 29, ABMC 2016/002; 15 *Ammonia aberdoveyensis* Haynes, 1973 rounded form, umbilical side, sample STZC 23, ABMC 2016/068; 16 *Ammonia aberdoveyensis* Haynes, 1973 lobate form, spiral side, sample STZC 27, ABMC 2016/021; 17 *Ammonia aberdoveyensis* Haynes, 1973 lobate form, umbilical side, sample STZC 19, ABMC 2016/077; 18 *Aubignyna perlucida* (Heron-Allen and Earland, 1913), spiral side, sample STZC 23, ABMC 2016/027; 19 *Ammonia beccarii* (Linnaeus, 1758), spiral side, sample STZC 29, ABMC 2016/045; 20 *Ammonia beccarii* (Linnaeus, 1758*)*, umbilical side, sample STZC 29, ABMC 2016/062; 21 *Ammonia falsobeccarii* (Rouvillois, 1974), spiral side, sample STZC 13, ABMC 2016/051; Scale bar 2-7, 9 – 50 µm; 1, 8, 10-21

Distribution and remarks. *Asterigerinata mamilla* occurs in infralittoral (optimum; Phipps et al., 2010), circalittoral and subordinately upper bathyal well oxygenated waters, mainly on sandy-vegetated bottoms (Sgarrella and Moncharmont Zei, 1993). An accessory species, present in ten samples of the Section C (RA=0.19%-1.02%) and two of the Section B (RA=0.16%-1.91%).

Asterigerinata mariae Sgarrella, 1990
Figure 11.3-4

1988 *Asterigerinata* sp. Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella: p. 975.

1990 *Asterigerinata mariae* Sgarrella (in Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella): pp. 477-478, pl. 3, figs. 1-8.

2012 *Asterigerinata mariae* Sgarrella; Milker and Schmiedl, p. 111, figs. 25.14-16.

Distribution and remarks. *Asterigerinata mariae* (epiphytic) is recorded on infralittoral fine sands/vegetated (optimum) and circalittoral/detritic bottoms (Sgarrella and Moncharmont Zei, 1993). It is present in the majority of the samples of the section C (RA range: 0.25%-4.88%) and in the sample STZB 5 (1.59%).

Family NONIONIDAE Schultze, 1854
Subfamily NONIONINAE Schultze, 1854
Genus HAYNESINA Banner and Culver, 1978
Haynesina depressula (Walker and Jacob, 1798)
Figure 11.5

1798 *Nautilus depressulus* Walker and Jacob: p. 641, pl. 14, fig. 33.

1988 *Haynesina depressula* (Walker and Jacob); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Haynesina depressula* (Walker and Jacob); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 1, figs. 4-5.

2012 *Haynesina depressula* (Walker and Jacob); Milker and Schmiedl, p. 112, figs. 25.17-18.

Distribution and remarks. A paralic-shallow marine species, mainly infralittoral (Sgarrella and Moncharmont Zei, 1993, as *Nonion depressulum*) which tolerates polyhaline waters (salinity >24‰; Alve and Murray, 1999) and stressed environment (Bergin et al., 2006); common in the La Starza sediments (RA range: 0.92% to 12.79%).

Haynesina germanica (Ehrenberg, 1840)
Figure 11.6-7

1840 *Nonionina germanica* Ehrenberg: p. 23.

1978 *Haynesina germanica* (Ehrenberg); Banner and Culver, pp. 191-200, pl. 4, figs. 1-6; pl. 5, figs. 1-8; pl. 6, figs. 1-7; pl. 7, figs. 1-6; pl. 8, figs. 1-10; pl. 9, figs. 1-11, 15, 17-18.

1988 *Nonion pauciloculum* (Cushman); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Nonion pauciloculum* (Cushman); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 2, fig. 2.

2004 *Haynesina germanica* (Ehrenberg); Armynot du Châtelet, Debenay and Soulard, pl. 1, figs. 5-6.

2013 *Haynesina germanica* (Ehrenberg); Pillet, Voltski, Korsun and Pawlowski, pl. 1, figs. c-d.

Distribution and remarks. *Haynesina germanica* is an euryhaline, eurythermal species, present in marginal, infralittoral and upper circalittoral environment, tolerant to polluted and stressed environments (Banner and Culver, 1978; Armynot du Châtelet et al., 2004; Armynot du Châtelet and Debenay, 2010). The species, frequently recorded (Coccioni et al., 2009) as *Nonion pauciloculum*, *Elphidium pauciloculum* and *Haynesina paucilocula* (Cushman, 1944) is not rare in the La Starza sediments, ranging from 0.41% to 3.64%.

Genus NONION de Montfort, 1808
Nonion fabum (Fichtel and Moll, 1798)
Figure 11.8

1798 *Nautilus faba* Fichtel and Moll: p. 103, pl. 19, figs. a-c.

2012 *Nonion fabum* (Fichtel and Moll); Milker and Schmiedl, p. 73, figs. 18.21.

Distribution and remarks. *Nonion fabum* is an outer shelf - upper bathyal species (Szarek, 2001), linked to organic matter (Goineau et al., 2011) and tolerant to low oxygen levels (Mojtahid et al., 2010). The species is present at La Starza in eight samples generally with low RA values (0.19%-5.13%).

Genus NONIONELLA Cushman, 1926
Nonionella turgida (Williamson, 1858)
Figure 11.9

1858 *Rotalina turgida* Williamson: p. 50, pl. 4, figs. 95-97.

1988 *Nonionella turgida* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Nonionella turgida* (Williamson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 2, fig. 6.

2012 *Nonionella turgida* (Williamson); Milker and Schmiedl, p. 113, figs. 26.1-6.

Distribution and remarks. A shelf-bathyal species, with optimum in the upper circalittoral zone

(Jorissen, 1987; Sgarrella and Moncharmont Zei, 1993). *N. turgida* is considered an opportunistic, stress tolerant species (Bergin et al., 2006; Frontalini and Coccioni, 2011; Barras et al., 2014) able to survive to anoxic conditions (Moodley et al., 1998). Common at La Starza, its RA ranges from 6.90% to 21.92%.

Subfamily ASTRONONIONINAE Saidova, 1981
Genus ASTRONONION Cushman and Edwards, 1937
Astrononion stelligerum (d'Orbigny, 1839)
Figure 11.10

1839b *Nonionina stelligera* d'Orbigny: p. 128, pl. 3, figs. 1-2.

2012 *Astronion stelligerum* (d'Orbigny); Milker and Schmiedl, p. 113, figs. 26.7-8.

Distribution and remarks. A shelf and upper bathyal species (Sen Gupta et al., 2009b; Szarek, 2001), showing low RA (0.18%-4.10%) both in the Section B and C.

Subfamily PULLENIINAE Schwager, 1877
Genus MELONIS de Montfort, 1808
Melonis affinis (Reuss, 1851)
Figure 11.11

1851 *Nonionina affinis* Reuss: p. 72, pl. 5, fig. 32.

1858 *Nonionina barleeana* Williamson: p. 32, pl. 3, figs. 68-69.

2009a *Melonis affinis* (Reuss); Sen Gupta, Lobegeier and Smith, pp. 98-99, pl. 103, figs. 1-2.

Distribution and remarks. We agree with the statement of authors (Van Marle, 1991; Sen Gupta et al., 2009a; Hayward et al., 2010) who consider *Nonionina barleeana* as a younger synonym of *N. affinis*. It is an eurybathic (Sen Gupta et al., 2009b) species, very rare in the upper infralittoral zone (Sgarrella and Moncharmont-Zei, 1993; Aiello, Barra and Parisi, pers. obs.). Few individuals of *M. affinis* occur at La Starza in the sample STZC 15.

Family TRICHOHYALIDAE Saidova, 1981
Genu AUBIGNYNA Margerel, 1970
Aubignyna perlucida (Heron-Allen and Earland, 1913)
Figure 11.18

1913 *Rotalia perlucida* Heron-Allen and Earland: p. 139, pl. 13, figs. 7-9.

1988 *Ammonia perlucida* (Heron-Allen and Earland); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Ammonia perlucida* (Heron-Allen and Earland); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2000 *Aubignyna perlucida* (Heron-Allen and Earland); Murray, Whittaker and Alve, pp. 61-64, pl. 1, figs. 1-14, fig. 1d.

Distribution and remarks. This infaunal, tolerant of stressed environment species (Frontalini and Coccioni, 2008), is present in eight samples of Section C (0.32%-7.37%) and two of the Section B (0.62%-0.64%).

Genus BUCCELLA Andersen, 1952
Buccella granulata (Di Napoli Alliata, 1952)
Figure 11.12-13

1952 *Eponides frigidus* (Cushman) var. *granulatus* Di Napoli Alliata: pp. 103, 107, pl. 5, fig. 3.

1988 *Buccella granulata* (Di Napoli Alliata); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 974.

1990 *Buccella granulata* (Di Napoli Alliata); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 480, 482.

2012 *Buccella granulata* (Di Napoli Alliata); Milker and Schmiedl, p. 117, figs. 26.26-27.

Distribution and remarks. *Buccella granulata* is common in the infralittoral - upper circalittoral Mediterranean waters, showing preference for vegetated, sandy bottoms (Jorissen, 1987, 1988). The species is recorded at La Starza in the majority of the fossiliferous samples (RA range: 0.25% to 12.24%).

Family ROTALIIDAE Ehrenberg, 1839
Subfamily AMMONIINAE Saidova, 1981
Genus AMMONIA Brünnich, 1772
Ammonia aberdoveyensis Haynes, 1973
Figure 11.14-17

1973 *Ammonia aberdoveyensis* Haynes: pp. 184-186, pl. 18, fig. 15; text-figs. 38.1-38.7.

1988 *Ammonia parkinsoniana* (d'Orbigny); Jorissen, pl. 2, fig. 8; pls. 7-10.

1988 *Ammonia tepida* (Cushman); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1988 *Ammonia tepida* (Cushman) f. 1; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Ammonia tepida* (Cushman); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl.1, figs. 1-2.

1990 *Ammonia tepida* (Cushman) f. 1; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2004 Molecular type T2 Hayward, Holzmann, Grenfell, Pawlowski and Triggs, pl. 2, T2; pl. 3, T2; pl. 4, T2; tab. 6, T2.

Distribution and remarks. The results of Holzmann and Pawlowski (2000) and Hayward et al. (2004), based on rDNA sequences, suggest that the mediterranean form commonly assigned to *A. parkinsoniana*, including *A. parkinsoniana* forma *parkinsoniana* and *A. p.* forma *tepida* (Cushman, 1926), extensively figured by Jorissen (1988), should be attributed to the Haynes' species. The authors report their Morphotype T2 (=*A. aberdoveyensis)* from European - North Atlantic microtidal marshes.

Jorissen (1988) recognized the "lobate" form (=*A. p.* forma *tepida*) as highly tolerant to environmental stress, lowered salinities and low oxygen waters. Bergin et al. (2006), who assigned it to *A. tepida*, have proposed the use of this form as "pollution indicator".

The "rounded" form (=*A. p.* forma *parkinsoniana*) is considered a morphotype commonly present in low salinity waters and in the depth range 10-20 m. In order to avoid loss of information we have assigned the two morphotypes to *A. aberdoveyensis* "lobate form" and *A. aberdoveyensis* "rounded form".

A. aberdoveyensis "lobate form" (figs. 11.16-17) is present in 21 samples of section STZC, with a maximum abundance of 14.83%, and in the two fossiliferous samples of section STZB.

A. aberdoveyensis "rounded form" (figs. 11.14-15) occurs in 17 samples of section STZC, with a maximum RA of 21.19%.

Ammonia beccarii (Linnaeus, 1758)
Figure 11.19-20

1758 *Nautilus beccarii* Linnaeus: p. 710 [figured by Plancus (1739) as *Cornu Hammonis*, pl. 1, fig. 1].

1988 *Ammonia beccarii* (Linnaeus); Jorissen, pp. 52-54, pl. 2, fig. 5, pl. 5, figs. 1-4, pl. 6, figs. 1-4.

1988 *Ammonia beccarii* (Linnaeus); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Ammonia beccarii* (Linnaeus); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 1 fig. 3.

1998 *Ammonia beccarii* (Linnaeus) s.s.; Debenay, Bénéteau, Zhang, Stouff, Geslin, Redois and Fernandez-Gonzalez, pl. 1, figs. 1-5, 8-9.

2004 *Ammonia beccarii* (Linnaeus); Hayward, Holzmann, Grenfell, Pawlowski and Triggs, pl. 2, fig. b, pl. 3, fig. b, pl. 4, fig. b.

Distribution and remarks. *Ammonia beccarii* is a mostly marine infralittoral species, which shows a preference for sandy and vegetated bottoms (Debenay et al., 1998). Due to the complex taxonomy of this species (Hayward et al., 2004), its capacity to tolerate low oxic bottom waters (Karlsen et al., 2000; Moodley and Hess, 1992), environmental stress (Yanko et al., 1999; Tsujimoto et al., 2006) as well as its dominance in paralic brackish environments (Murray, 2014) has to be referred to *A. beccarii* sensu lato. At La Starza the species has been recorded in Section C, ranging from 0.29% to 16.13%; its RA is high in low-diversity samples (STZC 16 and STZC 17). It lacks in the samples of the subcluster B2.

Ammonia falsobeccarii (Rouvillois, 1974)
Figure 11.21

1974 *Pseudoeponides falsobeccarii* Rouvillois: p. 3, pl. 1, figs. 1-12.

1988 "*Pseudoeponides*" *falsobeccarii* Rouvillois; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 "*Pseudoeponides*" *falsobeccarii* Rouvillois; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.

2011 *Ammonia falsobeccarii* (Rouvillois); Schweizer, Jorissen and Geslin, pp. 95-103.

Distribution and remarks. An infralittoral - upper circalittoral species typical of low-oxic, stressed environments (Schweizer et al., 2011). It is present in two samples of the Section C: STZC 13 (RA=14.83%) and STZC 18 (RA=0.42%).

Family ELPHIDIIDAE Galloway, 1933
Subfamily ELPHIDIINAE Galloway, 1933
Genus ELPHIDIUM de Montfort, 1808
Elphidium advenum (Cushman, 1922)
Figure 12.15

1922 *Polystomella advena* Cushman: p. 56, pl. 9, figs. 11-12.

1988 *Elphidium advenum* (Cushman); Jorissen, p. 102, pl. 2, figs. 9-10; pl. 24, figs. 3a-b; pl. 25, figs. 4, 6a-b.

Distribution and remarks. Our specimens fit very well with the form figured by Boltovskoy et al. (1980) as *E. advenum depressulum* Cushman, 1933. In our opinion, the wide morphological variability of the species does not allow the discrimination of *E. advenum* and *E. a. depressulum* not even at subspecific level. It is an infralittoral and upper circalittoral species (Jorissen, 1988; Sen Gupta et al., 2009b) present in six samples of the Section C, uncommon.

Elphidium articulatum (d'Orbigny, 1839)
Figure 12.1-2

1839c *Polystomella articulata* d'Orbigny: p. 30, pl. 3, figs. 9-10.

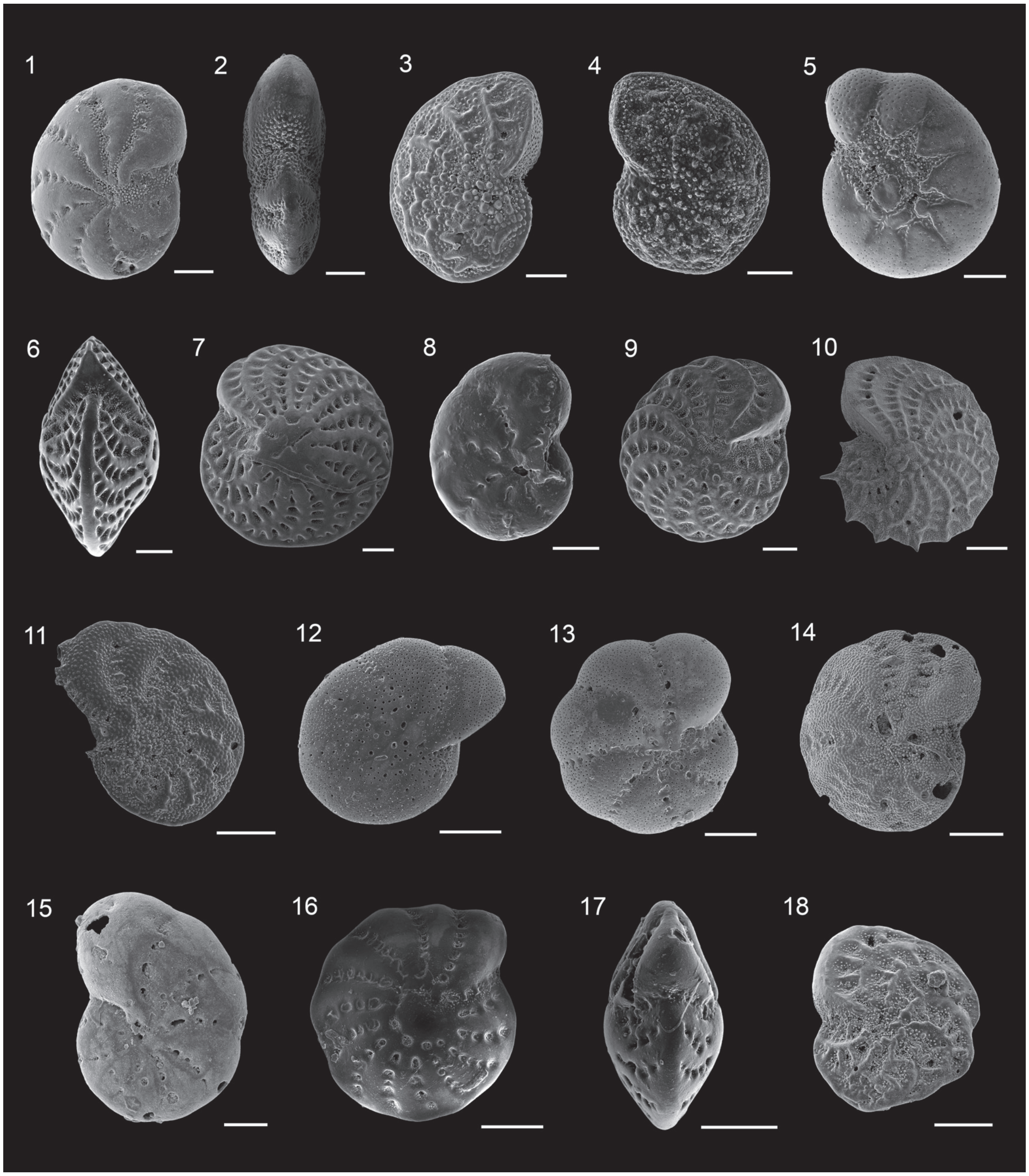

FIGURE 12. 1 *Elphidium articulatum* (d'Orbigny, 1839), side view, sample STZC 33, ABMC 2016/058; 2 *Elphidium articulatum* (d'Orbigny, 1839), peripheral view, sample STZC 32, ABMC 2017/010; 3 *Elphidium complanatum* (d'Orbigny) var. *tyrrhenianum* Accordi, 1951, side view, sample STZC 29, ABMC 2016/061; 4 *Elphidium complanatum* (d'Orbigny) var. *tyrrhenianum* Accordi, 1951, side view, sample STZC 17, ABMC 2017/008; 5 *Elphidium granosum* (d'Orbigny, 1826), side view, sample STZC 33, ABMC 2016/016; 6 *Elphidium crispum* (Linnaeus, 1758), peripheral view, sample STZC 30, ABMC 2017/002; 7 *Elphidium crispum* (Linnaeus, 1758), side view, sample STZC 32, ABMC 2016/034; 8 *Elphidium incertum* (Williamson, 1858), side view, STZC 29, ABMC 2016/075; 9 *Elphidium macellum* (Fichtel and Moll, 1798), side view, sample STZC 21, ABMC 2016/044; 10 *Elphidium macellum* (Fichtel and Moll, 1798), side view sample STZC 34, ABMC 2016/017; 11 *Elphidium maioricense* Colom, 1942, side view, sample STZC 34, ABMC 2016/019; 12 *Elphidium poeyanum* (d'Orbigny, 1839) FS form, side view, sample STZC 20, ABMC 2016/038; 13 *Elphidium poeyanum* (d'Orbigny, 1839) DS form, side view, sample STZC 20, ABMC 2016/050; 14 *Elphidium pulvereum* Todd, 1958, side view, sample STZC 32, ABMC 2016/052; 15 *Elphidium advenum* (Cushman, 1922), side view, sample STZC 24, ABMC 2016/072; 16 *Elphidium punctatum* (Terquem, 1878), side view, sample STZC 32, ABMC 2017/011; 17 *Elphidium punctatum* (Terquem, 1878), peripheral view, sample STZC 32, ABMC 2017/012; 18 *Parrellina verriculata* (Brady, 1881), side view, sample STZC 20, ABMC 2016/067; Scale bar 1-5, 8, 15 – 50 μm; 6, 7, 9-14, 16-18 – 100 μm.

1980 *Elphidium articulatum* (d'Orbigny); Boltovskoy, Giussani, Watanabe and Wright, p. 29, pl. 13, figs. 1-4.

1988 *Elphidium articulatum* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Elphidium articulatum* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2002 *Elphidium articulatum* (d'Orbigny); Kaminski, Aku, Box, Hiscott, Filipescu and Al-Salameen, p. 190, pl. 5, figs. 10a-b.

Distribution and remarks. The discrimination between this species and *E. williamsoni* Haynes, 1973 remains still unclear. *E. articulatum* is generally recorded in paralic and in marine infralittoral waters (Boltovskoy et al., 1980; Sen Gupta et al., 2009b; Rodrigues et al., 2014); common in the fossiliferous samples of La Starza (RA range: 0.38% to 12.39%).

Elphidium complanatum (d'Orbigny) var. *tyrrhenianum* Accordi, 1951
Figure 12.3-4

1951 *Elphidium complanatum* (d'Orbigny) var. *tyrrhenianum* Accordi: p. 126, pl. 2, figs. a-b.

1988 *Elphidium complanatum* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Elphidium complanatum* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2012 *Elphidium complanatum* (d'Orbigny) var. *tyrrhenianum* Accordi; Milker and Schmiedl, p. 120, figs. 27.11-12.

Distribution and remarks. The specimens occurring in nine samples (RA range from 0.29 to 9.68%) can be referred to the form *tyrrhenianum* described by Accordi (1951). *E. complanatum* s.l. is a shelf species, common on sandy bottoms in high energy environment (Milker et al., 2009).

Elphidium crispum (Linnaeus, 1758)
Figure 12.6-7

1758 *Nautilus crispum* Linnaeus: p. 709.

1988 *Elphidium crispum* (Linnaeus); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Elphidium crispum* (Linnaeus); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2012 *Elphidium crispum* (Linnaeus); Milker and Schmiedl, p. 120, figs. 27.13-14.

Distribution and remarks. *E. crispum* is an infralittoral - upper circalittoral species, epiphyte, associated with carbonate-rich, sandy bottoms (Avnaim-Katav et al., 2015). Present in the La Starza sediments in almost all the fossiliferous samples (RA from 0.64% to 9.76%).

Elphidium granosum (d'Orbigny, 1826)
Figure 12.5

1826 *Nonionina granosa* d'Orbigny: p. 294, n. 8.

1846 *Nonionina granosa* d'Orbigny; d'Orbigny, p. 110, pl. 5, figs. 19-20.

1988 *Protelphidium granosum* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Protelphidium granosum* (d'Orbigny); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 1, fig. 6.

2012 *Elphidium granosum* (d'Orbigny); Milker and Schmiedl, p. 121, figs. 27.17-18.

Distribution and remarks. It is a paralic, infralittoral and subordinately upper circalittoral species, preferring unstressed conditions and tolerating low salinity waters (Jorissen, 1988; Murray, 2006; Phipps et al., 2010). Common in the La Starza sediments. The assemblage of the sample STZC 7 consists of one specimen of *E. granosum*; in the remaining samples the abundance range is 0.82-22.58%.

Elphidium incertum (Williamson, 1858)
Figure 12.8

1858 *Polystomella umbilicula* Walker var. *incertum* Williamson: p. 44, pl. 3, fig. 82.

2006 *Elphidium incertum* (Williamson); Horton and Edwards, p. 76, pl. 4, figs. 18 a-b.

2012 *Elphidium incertum* (Williamson); Milker and Schmiedl, p. 121, figs. 27.19-20.

Distribution and remarks. *Elphidium incertum* is a marginal-infralittoral, subordinately circalittoral, species that tolerates dysoxic environment (Alve, 1990; Jorissen et al., 2007); it prefers muddy and sandy muddy bottoms (Polovodova et al., 2009). Very rare at La Starza, the species is present only in the samples STZC 20 (0.38%) and STZC 29 (0.55%).

Elphidium macellum (Fichtel and Moll, 1798)
Figure 12.9-10

1798 *Nautilus macellus* Fichtel and Moll: p. 66, pl.10, figs. e-g, h-k.

1964 *Elphidium macellum* (Fichtel and Moll); Rodriquez, p. 115, pl. 6, fig. II.9.

1988 *Elphidium macellum* (Fichtel and Moll); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Elphidium macellum* (Fichtel and Moll); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

2012 *Elphidium macellum* (Fichtel and Moll); Milker and Schmiedl, p. 122, figs. 27.21-22.

Distribution and remarks. A marginal to upper circalittoral, mainly infralittoral species which tolerates low salinity waters (Oflaz, 2006; Sen Gupta et al., 2009b; Murray, 2014). Pillet et al. (2013) suggest that the "spinose keel" is not a "species specific feature". Following these authors, the specimens assigned in literature to *E. aculeatum* (d'Orbigny, 1846) generally pertain to *E. macellum* or, alternatively, to *E. crispum*. Furthermore they suggest that d'Orbigny (1846) described as *Polystomella aculeata* a spinose form of *E. macellum*. The observed morphological variability supports the statement of Pillet et al. (2012, 2013), leading us to include the aculeate form present in the La Starza sediments (Figure 12.10) in *E. macellum.*

Common in the La Starza sediments, it occurs in the majority of the fossiliferous samples, with RA ranging from 0.66 to 7.32%.

Elphidium maioricense Colom, 1942
Figure 12.11

1942 *Elphidium maioricensis* (sic) Colom: p. 34, pl. 10, figs. 189-193.

1993 *Elphidium maioricense* Colom; Sgarrella and Moncharmont-Zei, p. 229, pl. 21, figs. 10-13.

Distribution and remarks. A shallow, mainly infralittoral, phytophilous species (Sgarrella and Moncharmont, 1993), possibly endemic of the Mediterranean Sea. It occurs at La Starza in five samples (RA range: 0.21%-7.32%).

Elphidium poeyanum (d'Orbigny, 1839)
Figure 12.12-13

1839a *Polystomella poeyana* d'Orbigny: p. 55, pl. 6, figs. 25-26.

1988 *Elphidium excavatum* (Terquem); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1988 "*Elphidiononion*" *cuvilleri* (Levy); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Elphidium excavatum* (Terquem); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 1, fig. 7.

1990 "*Elphidiononion*" *cuvilleri* (Levy); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482, pl. 2, fig. 1.

1988 *Elphidium poeyanum* (d'Orbigny); Jorissen, pp. 116-120, pl. 2 figs. 4, 6; pls. 20-23.

Distribution and remarks. The high morphological variability of this marginal - upper bathyal (Jorissen, 1988; Murray, 2006; Sen Gupta et al., 2009b) species has been thoroughly documented by Jorissen (1988) who observed "a gradual variation between two extreme morphotypes." The first one, named by the author *Elphidium poeyanum* forma *poeyanum*, has "a comparatively small number of inflated chambers, depressed sutures and a relatively open umbilicus"; its common presence indicates moderately stressed environmental conditions. The relationship between this morph, that is *E. poeyanum s.s.* (with depressed sutures: DS) and *E. excavatum* Terquem, 1875 is not clear. The second morph, called by Jorissen *Elphidium poeyanum* forma *decipiens* (Costa, 1856), shows "a higher number of chambers, flush sutures and an umbilicus filled by glassy material" and is typical of unstressed environment. Within the morph with "flush sutures" (FS form) both *E. translucens* Natland, 1938 and *E. cuvillieri* Lévy, 1966 have been included. The assignment of the FS form to *Polystomella decipiens* by Jorissen is based on the figures of Fornasini (1898) of Costa's material. Unfortunately the Fornasini's pictures are quite different from the original drawings, thus we prefer to avoid using the specific name *decipiens* for this morphotype.

Due to the different ecological preferences reported we have considered appropriate the discrimination of the two forms, herein named *E. poyeanum* DS form and *E. poeyanum* FS form.

Both morphs are common in the La Starza deposits, with RA respectively, ranging from 0.33% to 13.14% (*E. poeyanum* "FS form"; fig. 12.12) and from 0.51%-16.96% (*E. poeyanum* "DS form"; fig. 12.13).

Elphidium pulvereum Todd, 1958
Figure 12.14

1958 *Elphidium pulvereum* Todd: p. 201, pl. 1, figs. 19-20.

1988 *Elphidium pulvereum* Todd; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.

1990 *Elphidium pulvereum* Todd; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.

1993 *Elphidium pulvereum* Todd; Sgarrella and Moncharmont, p. 230, pl. 21, fig. 6.

2001b *Elphidium pulvereum* Todd; Debenay, Tsakiridis, Soulard, and Grossel, pl. 6, fig. 6.

Distribution and remarks. A stress tolerant, paralic and infralittoral epiphytic species present in circalittoral environment (Sgarrella and Moncharmont, 1993; Debenay et al., 2001b; Debenay and Guillou, 2002); not rare at La Starza with RA ranging from 0.18% to 9.68%.

Elphidium punctatum (Terquem, 1878)
Figure 12.16-17

1878 *Polystomella punctata* Terquem: p. 16, pl. 1, figs. 7a-b.
1964 *Elphidium advenum* (Cushman); Rodriquez, p. 115, pl. 6, figs. II.10, 12.
1988 *Elphidium punctatum* (Terquem); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.
1990 *Elphidium punctatum* (Terquem); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 481-482.
1993 *Elphidium punctatum* (Terquem); Sgarrella and Moncharmont-Zei, p. 230, pl. 21, figs. 3-4.
2012 *Elphidium advenum* (Cushman); Milker and Schmiedl, p. 119, figs. 27.7-8.

Distribution and remarks. An infralittoral and subordinately circalittoral species, frequently reported as *Elphidium advenum*. The comparison of the Terquem's figures with the original pictures of *Polystomella advena* Cushman, 1922 in edge view suggests they are two distinct species. *Elphidium punctatum* is present in the majority of the assemblages of La Starza, ranging from 0.29% to 16.13%.

Subfamily NOTOROTALIINAE Hornibrook, 1961
Genus PARRELLINA Thalmann, 1951
Parrellina verriculata (Brady, 1881)
Figure 12.18

1881 *Polystomella verriculata* Brady: p. 66.
1988 *Parrellina verriculata* (Brady); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 975.
1990 *Parrellina verriculata* (Brady); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 482.
2012 *Parrellina verriculata* (Brady); Milker and Schmiedl, p. 122, figs. 27.27-28.

Distribution and remarks. Rare specimens of this infralittoral and upper circalittoral species (Sgarrella and Moncharmont Zei, 1993) occur in Section C.

Class OSTRACODA Latreille, 1802
Subclass PODOCOPA Sars, 1866
Order PODOCOPIDA Sars, 1866
Suborder CYTHEROCOPINA Baird, 1850
Superfamily CYTHEROIDEA Baird, 1850
Family CUSHMANIDEIDAE Puri, 1974
Genus PONTOCYTHERE Dubowsky, 1939
Pontocythere turbida (Müller, 1894)
Figure 13.10

1894 *Cytheridea turbida* Müller: p. 361, pl., 30, figs. 28, 31-33, 40-45, 47.
1988 *Pontocythere turbida* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.
1990 *Pontocythere turbida* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484-485.
2015 *Pontocythere turbida* (Müller 1894); Frezza and Di Bella, pl. 1, figs. 17-18.

Distribution and remarks. *Pontocythere turbida* is commonly recorded in the infralittoral and upper circalittoral of the Mediterranean Sea (Frezza and Di Bella, 2015). At La Starza the species occurs, not rare, in the upper part of the Section C.

Family CYTHERETTIDAE Triebel, 1952
Genus CYTHERETTA Müller, 1894
Cytheretta adriatica Ruggieri, 1952

1952 *Cytheretta adriatica* Ruggieri: p. 36.
1977 *Cytheretta adriatica* Ruggieri; Athersuch, pp. 69-78.

Distribution and remarks. An accessory species, typical of the infralittoral zone (Athersuch, 1977), showing low RA in the La Starza assemblages.

Cytheretta subradiosa (Roemer, 1838)
Figure 13.5-6

1838b *Cytherina subradiosa* Roemer: p. 517, pl. 6, fig. 20.
1976a *Cytheretta subradiosa* (Roemer); Bonaduce, Ciampo and Masoli, pp. 54-55, pl. 32, figs. 1-6.

Distribution and remarks. *Cytheretta subradiosa* occurs in the upper circalittoral and infralittoral zones (Bonaduce et al., 1976a, 1977). In the La Starza assemblages the species shows RA ranges of 0.09%-6.98% (MNI) and 0.35-10.81% (TNV).

Family CYTHERIDEIDAE Sars, 1925
Genus CYTHERIDEA Bosquet, 1852
Cytheridea neapolitana Kollmann, 1960
Figure 13.8-9

1960 *Cytheridea neapolitana* Kollmann: p. 152, pl. 7, figs. 7-10, text-figs. 3a-b, d.
1988 *Cytheridea neapolitana* Kollmann; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.
1990 *Cytheridea neapolitana* Kollmann; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485, pl. 4, fig. 4.
2015 *Cytheridea neapolitana* Kollmann; Frezza and Di Bella, pl. 1, figs. 13-14.

Distribution and remarks. A shelf species linked to muddy sediments, rich in organic matter. *Cytheridea neapolitana* is rare in the uppermost infralitto-

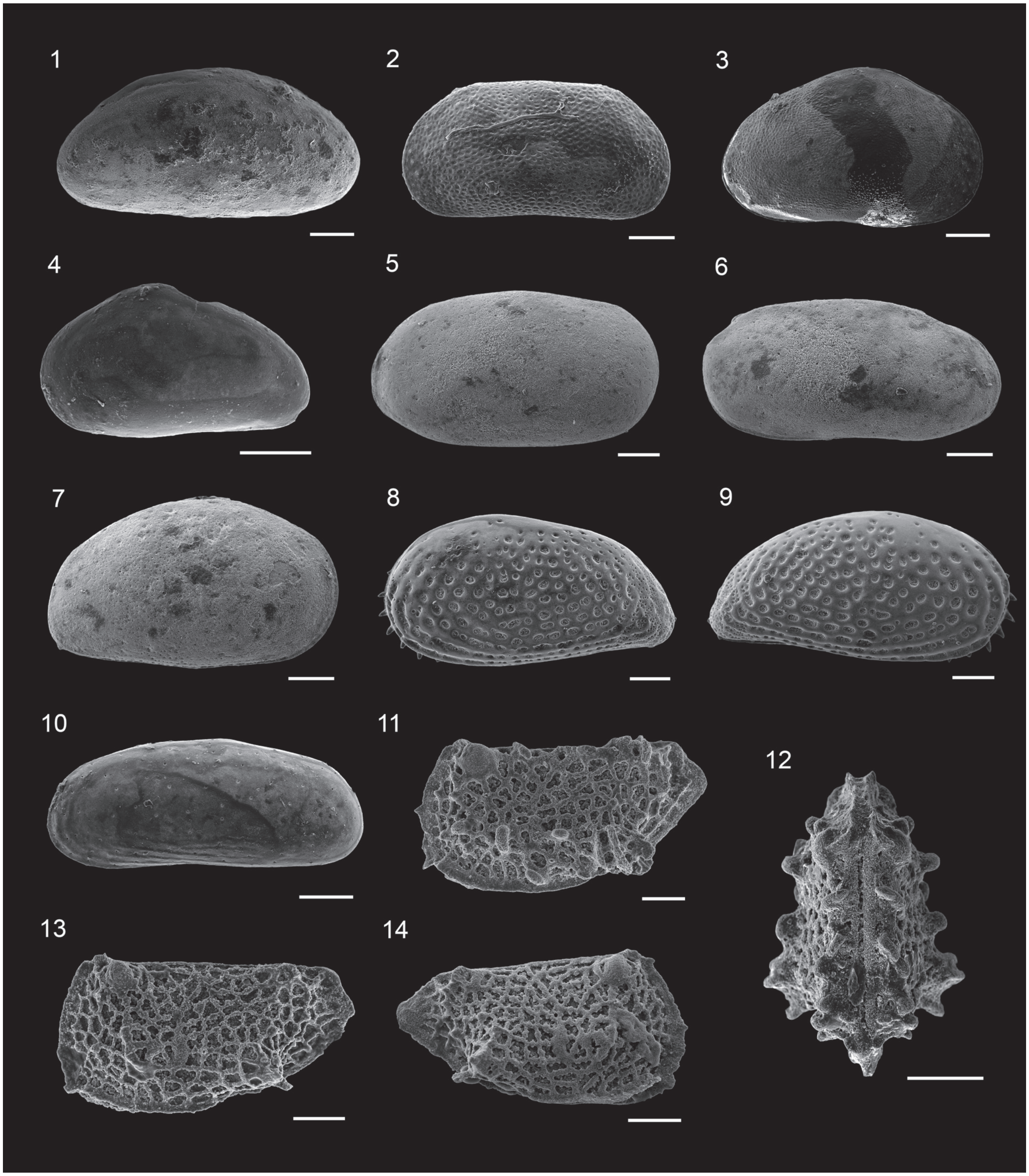

FIGURE 13. 1 *Propontocypris* ? *pellucida* (Müller, 1894), right valve, sample STZC 32, ABMC 2017/084; 2 *Pseudocandona sarsi* (Hartwig, 1899), left valve, sample STZC 29, ABMC 2017/068; 3 *Cypris pubera* O.F. Müller, 1776, juv, right valve, sample STZC 29, ABMC 2017/070; 4 *Cypridopsis* sp., left valve, sample STZC 29, ABMC 2017/094; 5 *Cytheretta subradiosa* (Roemer, 1838), left valve, sample STZC 22, ABMC 2017/072; 6 *Cytheretta subradiosa* (Roemer, 1838), right valve, sample STZC 22, ABMC 2017/061; 7 *Cyprideis torosa* (Jones, 1850), right valve, sample STZC 29, ABMC 2017/056; 8 *Cytheridea neapolitana* Kollmann, 1960, left valve, sample STZC 25, ABMC 2017/036; 9 *Cytheridea neapolitana* Kollmann, 1960, right valve, sample STZC 33, ABMC 2017/062; 10 *Pontocythere turbida* (Müller, 1894), left valve, sample STZC 28, ABMC 2017/050; 11 *Eucytherura gibbera* Müller, 1894, left valve, sample STZC 30, ABMC 2017/020; 12 *Eucytherura gibbera* Müller, 1894, carapace in dorsal view, sample STZC 28, ABMC 2017/092; 13 *Eucytherura mistrettai* Sissingh, 1972, left valve, sample STZC 29, ABMC 2017/025; 14 *Eucytherura mistrettai* Sissingh, 1972, right valve, sample STZC 33, ABMC 2017/077; Scale bar 11, 12, 14 – 50 µm; 1-10, 13 – 100 µm.

ral zone (0-3 m bsl) and its RA does not exceed 10% in the depth range 3-25 m bsl (Aiello, Barra and Parisi, pers. obs.); this species shows its optimum in the depth range 30-125 m bsl (Bonaduce et al., 1976a, 1977; Bakir et al., 2014; Frezza and Di Bella, 2015). The species is common in the La Starza assemblages, with RA ranging from 0.24% to 31.07% (MNI) and 0.40% to 28.33% (TNV). In the sample STZC 15 the assemblage consists exclusively of *C. neapolitana*.

Family CYTHERURIDAE Müller, 1894
Genus EUCYTHERURA Müller, 1894
Eucytherura gibbera Müller, 1894
Figure 13.11-12

1894 *Eucytherura gibbera* Müller: p. 307, pl. 19, figs. 21-26; pl. 20, figs. 14, 16, 19; pl. 21, figs. 1-2.

1977 *Eucytherura gibbera* Müller; Bonaduce, Masoli and Pugliese, pl. 4, fig. 2.

1988 *Eucytherura gibbera* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Eucytherura gibbera* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 483.

Distribution and remarks. A rare shelf species (Müller, 1894; Bonaduce et al., 1977; Yassini, 1979) occurring in three samples of the Section C.

Eucytherura mistrettai Sissingh, 1972
Figure 13.13-14

1972 *Eucytherura mistrettai* Sissingh: p. 140.

1976a *Eucytherura mistrettai* Sissingh; Bonaduce, Ciampo and Masoli, pl. 49, figs. 1-7.

Distribution and remarks. *E. mistrettai* is a mainly circalittoral species generally recorded below 70 m bsl (Bonaduce et al., 1976a, 1977). Rare in the La Starza section, it is present with few valves in two samples.

Genus HEMICYTHERURA Elofson, 1941
Hemicytherura defiorei Ruggieri, 1953
Figure 14.1

1953 *Hemicytherura defiorei* Ruggieri: p. 50, figs. 8-8a, 11-13.

1988 *Hemicytherura defiorei* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Hemicytherura defiorei* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

2004 *Hemicytherura defiorei* Ruggieri; Aiello and Szczechura, pp. 39-40, pl. 9, figs. 3-4.

Distribution and remarks. An infralittoral - upper circalittoral species not recorded below 108 m bsl (extended references in Aiello and Szczechura, 2004). Rare specimens are present in the uppermost part of Section C.

Hemicytherura videns (Müller, 1894)

1894 *Cytheropteron videns* Müller: p. 303, pl. 20, figs 2, 8; pl. 21, figs. 15-16, 18.

1988 *Hemicytherura videns* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Hemicytherura videns* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 483.

2004 *Hemicytherura videns* (Müller); Aiello and Szczechura, p. 40, pl. 9, figs. 1-2.

Distribution and remarks. A phytophilous, mainly infralittoral species (extended references in Aiello and Szczechura, 2004), rare both in Sections B and C.

Genus MICROCYTHERURA Müller, 1894
Microcytherura fulva (Brady and Robertson, 1874)
Figure 14.2-3

1874 *Cytherura fulva* Brady and Robertson: p. 116, pl. 4, figs. 1-5.

1976a *Microcytherura fulva* (Brady and Robertson); Bonaduce, Ciampo and Masoli, p. 89, pl. 57, figs. 9-13.

1997 *Microcytherura fulva* (Brady and Robertson); Barra, p. 75, pl. 1, fig. 8.

Distribution and remarks. An accessory species, living in the infralittoral and upper circalittoral zone (Bonaduce et al., 1976a; Rosenfeld, 1977; Aiello et al., 2006), occurring at La Starza in the samples STZC 29 and STZC 31.

Genus PSEUDOCYTHERURA Dubowsky, 1939
Pseudocytherura strangulata Ruggieri, 1991
Figure 14.10-11

1976a *Pseudocytherura calcarata (*Seguenza); Bonaduce, Ciampo and Masoli, pp. 90-91, pl. 50, figs. 7-12. (non *Cytheropteron calcaratum* Seguenza, 1880).

1991 *Pseudocytherura strangulata* Ruggieri: pp. 68-69.

Distribution and remarks. An infralittoral and circalittoral species (Bonaduce et al. 1976a; Aiello et al., 2006) present only in the sample STZC 27.

Genus SEMICYTHERURA Wagner, 1957
Semicytherura alifera Ruggieri, 1959
Figure 14.5-6

1894 *Cytherura alata* Müller: p. 288, pl. 18, figs. 1, 7-8; pl. 19, fig. 9.

1959 *Semicytherura alifera* Ruggieri; p. 204 (new name).

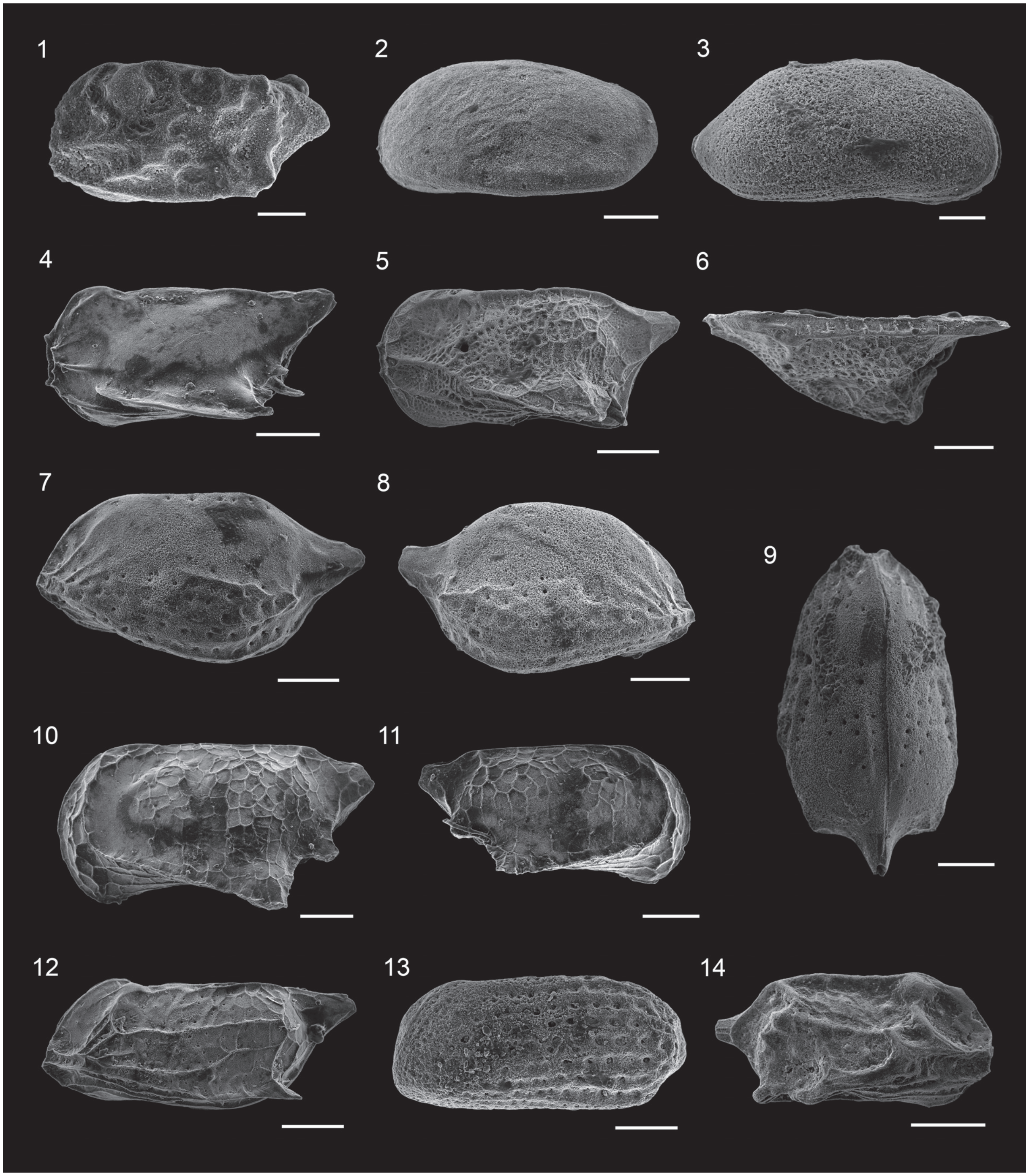

FIGURE 14. 1 *Hemicytherura defiorei* Ruggieri, 1953, left valve, sample STZC 34, ABMC 2017/091; 2 *Microcytherura fulva* (Brady and Robertson, 1874), left valve, sample STZC 31, ABMC 2017/078; 3 *Microcytherura fulva* (Brady and Robertson, 1874), right valve, sample STZC 29, ABMC 2017/076; 4 *Semicytherura paradoxa* (Müller, 1894), left valve, sample STZC 27, ABMC 2017/035; 5 *Semicytherura alifera* Ruggieri, 1959, left valve, sample STZC 23, ABMC 2017/041; 6 *Semicytherura alifera* Ruggieri, 1959, left valve in dorsal view, sample STZC 23, ABMC 2017/041; 7 *Semicytherura incongruens* (Müller, 1894), left valve, sample STZC 28, ABMC 2017/034; 8 *Semicytherura incongruens* (Müller, 1894), right valve, sample STZC 21, ABMC 2017/043; 9 *Semicytherura incongruens* (Müller, 1894), carapace in dorsal view, sample STZC 32, ABMC 2017/067; 10 *Pseudocytherura strangulata* Ruggieri, 1991, left valve, sample STZC 27, ABMC 2017/053; 11 *Pseudocytherura strangulata* Ruggieri, 1991, juv, right valve, sample STZC 27, ABMC 2017/015; 12 *Semicytherura ruggierii* (Pucci, 1955), left valve, sample STZC 27, ABMC 2017/044; 13 *Semicytherura sulcata* (Müller, 1894), left valve, sample STZC 33, ABMC 2017/024; 14 *Semicytherura dispar* (Müller, 1894), right valve, sample STZC 32, ABMC 2017/057; Scale bar 1-3 – 50 μm; 4-14 – 100 μm.

1976a *Semicytherura alifera* Ruggieri; Bonaduce, Ciampo and Masoli, p. 70, pl. 44, figs. 3-9.

1988 *Semicytherura alifera* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura alifera* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484-485.

Distribution and remarks. Rare shells of *Semicytherura alifera,* an infralittoral and upper circalittoral species (Bonaduce et al., 1976a, 1977, 1988; Breman, 1976), occur in three samples of Section C.

Semicytherura dispar (Müller, 1894)
Figure 14.14

1894 *Cytherura dispar* Müller: p. 293, pl. 19, fig. 16; pl. 20, figs. 1, 6-7.

1976a *Semicytherura dispar* (Müller); Bonaduce, Ciampo and Masoli, pp. 71-72, pl. 40, figs. 6-9.

1988 *Semicytherura dispar* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura dispar* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

Distribution and remarks. *Semicytherura dispar* lives from the upper part of the infralittoral zone up to the upper circalittoral (Barbeito-Gonzalez, 1971; Uffenorde, 1972; Bonaduce et al., 1976a, 1977, 1988; Aiello et al., 2006). Rare and scattered valves have been recorded in Section C.

Semicytherura incongruens (Müller, 1894)
Figure 14.7-9

1894 *Cytherura incongruens* Müller: p. 296, pl. 17, figs. 2, 7-8; pl. 19, fig. 7.

1976a *Semicytherura incongruens* (Müller, 1894); Bonaduce, Ciampo and Masoli, p. 72, pl. 40, figs. 12-15.

1988 *Semicytherura incongruens* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura incongruens* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484-485.

Distribution and remarks. *S. incongruens* is a shelf species, characteristic of the infralittoral and upper circalittoral zone of the Mediterranean (Uffenorde, 1972; Bonaduce et al., 1976a, 1977, 1988; Frezza and Di Bella, 2015). The species is well represented in the fossiliferous levels of the La Starza succession, reaching a maximum RA value of 53.85% (MNI).

Semicytherura paradoxa (Müller, 1894)
Figure 14.4

1894 *Cytherura paradoxa* Müller: p. 294, pl. 17, figs. 3, 9; pl. 19, fig. 12.

1976a *Semicytherura paradoxa* (Müller); Bonaduce, Ciampo and Masoli, p. 74, pl. 44, figs. 1-2.

1988 *Semicytherura paradoxa* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura paradoxa* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

Distribution and remarks. An infralittoral species (Barbeito-Gonzalez, 1971; Uffenorde, 1972; Bonaduce et al., 1976a; Aiello et al., 2006) rare at La Starza, where it has been recorded in two samples of Section C.

Semicytherura rara (Müller, 1894)

1894 *Cytherura rara* Müller: p. 299, pl. 17, figs. 14-15; pl. 19, fig. 20.

1976a *Semicytherura rara* (Müller); Bonaduce, Ciampo and Masoli, p. 76, pl. 46, figs. 8-9.

1988 *Semicytherura rara* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura rara* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

Distribution and remarks. Some poor preserved valves of this shelf species (Bonaduce et al., 1976a, 1977, 1988; Aiello et al., 2006) have been recorded in two samples of Section C.

Semicytherura rarecostata Bonaduce, Ciampo and Masoli, 1976

1976a *Semicytherura rarecostata* Bonaduce, Ciampo and Masoli: pp. 76-77, pl. 46, figs. 10-12.

1988 *Semicytherura rarecostata* Bonaduce, Ciampo and Masoli; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura rarecostata* Bonaduce, Ciampo and Masoli; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

Distribution and remarks. A shelf species showing its optimum in upper circalittoral waters (Bonaduce et al., 1976a; Aiello, Barra and Parisi, pers. obs.). *S. rarecostata* is present in Section C in three samples, displaying low RA.

Semicytherura ruggierii (Pucci, 1955)
Figure 14.12

1955 *Cytherura ruggierii* Pucci: p. 167, pl. 1, figs. 3-4; text-fig. 1.

1976a *Semicytherura ruggierii* (Pucci); Bonaduce, Ciampo and Masoli, p. 79, pl. 38, figs. 1-10.

1988 *Semicytherura ruggierii* (Pucci); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura ruggierii* (Pucci); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484, 485.

Distribution and remarks. *Semicytherura ruggierii* is a shelf species, present up to the upper bathyal (Uffenorde, 1972; Bonaduce et al., 1976a, 1977, 1988), very rare in the uppermost part of the infralittoral zone (Aiello et al., 2006; Perçin-Paçal and Balkis, 2012). The species is not rare in Section C, reaching a RA of 13.27% (MNI).

Semicytherura sulcata (Müller, 1894)
Figure 14.13

1894 *Cytherura sulcata* Müller: p. 297, pl. 17, figs. 4, 10; pl. 19, fig. 19.

1976a *Semicytherura sulcata* (Müller); Bonaduce, Ciampo and Masoli, pp. 80-81, pl. 39, figs. 6-10.

1988 *Semicytherura sulcata* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Semicytherura sulcata* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484-485.

Distribution and remarks. An infralittoral and upper circalittoral species (Bonaduce et al., 1976a, 1977, 1988; Aiello et al., 2006; Balassone et al., 2016; Mangoni et al., 2016) not rare in the upper part of Section C with a maximum value of 11.49% (MNI).

Family EUCYTHERIDAE Puri, 1954
Genus EUCYTHERE Brady, 1868
Eucythere curta Ruggieri, 1975
Figure 15.1

1975 *Eucythere curta* Ruggieri: p. 433, fig. 6.

1976a *Eucythere curta* Ruggieri; Bonaduce, Ciampo and Masoli, p. 63, pl. 37, figs. 9-13.

1988 *Eucythere curta* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella p. 976.

1990 *Eucythere curta* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

Distribution and remarks. A mainly circalittoral species, very rare in infralittoral waters (Ruggieri, 1975; Bonaduce et al., 1976a, 1977, 1988; Aiello et al., 2006). Present in three samples of Section C with low RA values.

Family HEMICYTHERIDAE Puri, 1953
Genus AURILA Pokorný, 1955
Aurila convexa (Baird, 1850)

1850 *Cythere convexa* Baird: p. 174, pl. 21, fig. 3.

1989 *Aurila convexa* (Baird); Athersuch, Horne and Whittaker, pp. 157-158, figs. 62a-f, pl. 5, fig. 1.

Distribution and remarks. *Aurila convexa* is an infralittoral and upper circalittoral phytal species (Bonaduce et al., 1976a, 1977; Athersuch et al., 1989). At La Starza few specimens have been recorded.

Aurila prasina Barbeito-Gonzalez, 1971

1971 *Aurila prasina* Barbeito-Gonzalez: p. 277, pl. 12, figs. 1a-3a; pl. 46, figs. 11-12.

1976a *Aurila prasina* Barbeito-Gonzalez; Bonaduce, Ciampo and Masoli, pl. 20, figs. 1-7.

Distribution and remarks. Rare valves of this upper infralittoral species (Barbeito-Gonzalez, 1971; Bonaduce et al., 1976a; Aiello et al., 2006) are present in Section C.

Genus UROCYTHEREIS Ruggieri, 1950
Urocythereis ilariae Aiello, Barra and Parisi, 2016

2016 *Urocythereis ilariae* Aiello, Barra and Parisi: pp. 19-21, figs. 2B; 3G-H; 4G-H; 5G-H; 6G-H; 14; 18A-J; 19A-C, E-J.

Distribution and remarks. *Urocythereis ilariae* is an infralittoral species (Aiello et al., 2016) uncommon at La Starza, where is generally present with low RA.

Urocythereis margaritifera (Müller, 1894)

1894 *Cythereis margaritifera* Müller: p. 368, pl. 32, figs. 26, 29, 32, 35-37.

2016 *Urocythereis margaritifera* (Müller); Aiello, Barra and Parisi, pp. 21-23, figs. 2A; 3A-F; 4A-F; 5A-F; 6A-F; 16A-K; 17A-J; 19D.

Distribution and remarks. A species characteristic of the infralittoral sandy bottoms of the Mediterranean, displaying a high morphological variability (Aiello et al., 2016). Relatively uncommon at La Starza, shows a maximum RA value of 9.01% (TNV).

Family KRITHIDAE Mandelstam, 1958
Genus PSEUDOPSAMMOCYTHERE Carbonnel, 1966
Pseudopsammocythere reniformis (Brady, 1868)
Figure 15.2

1868 *Paradoxostoma* (?) *reniforme* Brady: p. 224, pl. 15, figs. 1-2.

1894 *Krithe reniformis* (Brady); Müller, pp. 358-359, pl. 28, fig. 24; pl. 30, figs. 1, 3-16, 22-23.

1976 *Pseudopsammocythere reniformis* (Brady); Breman, p. 55, pl. 11, fig. 26.

Distribution and remarks. This mainly infralittoral species (Uffenorde, 1972; Breman, 1976; Bonaduce et al., 1988) is continuously present in the

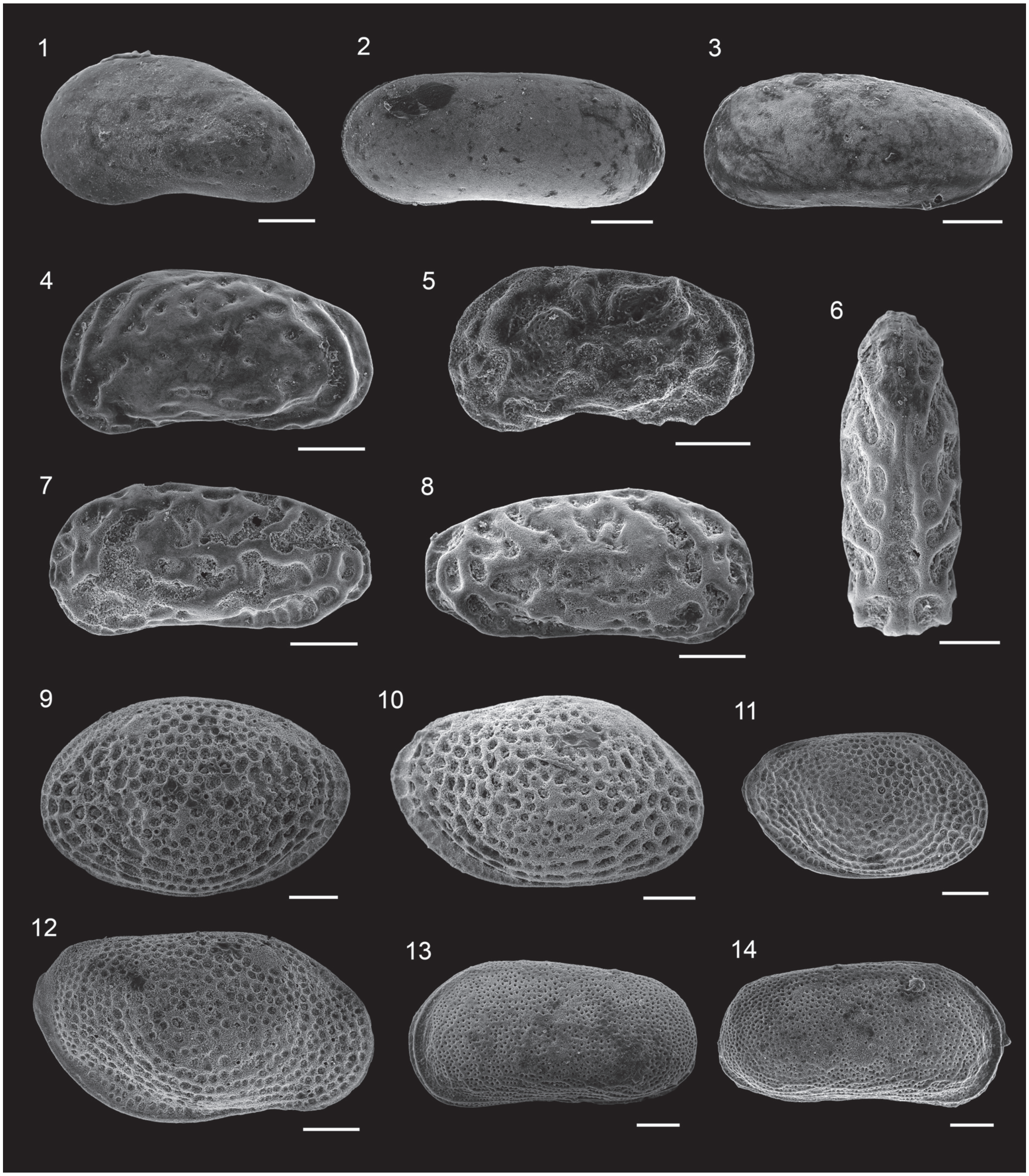

FIGURE 15. 1 *Eucythere curta* Ruggieri, 1975, left valve, sample STZC 25, ABMC 2017/058; *2 Pseudopsammocythere reniformis* (Brady, 1868), left valve, sample STZC 10, ABMC 2017/017; 3 *Leptocythere ramosa* (Rome, 1942), left valve, sample STZC 27, ABMC 2017/033; 4 *Callistocythere badia* (Norman, 1862), left valve, sample STZC 27, ABMC 2017/048; 5 *Callistocythere littoralis* (Müller, 1894), left valve, sample STZC 34, ABMC 2017/016; 6 *Callistocythere flavidofusca* (Ruggieri, 1950), carapace in dorsal view, sample STZC 19, ABMC 2017/074; 7 *Callistocythere flavidofusca* (Ruggieri, 1950), left valve, sample STZC 32, ABMC 2017/019; 8 *Callistocythere flavidofusca* (Ruggieri, 1950), right valve, sample STZC 28, ABMC 2017/059; 9 *Loxoconcha ovulata* (Costa, 1863), left valve, sample STZC 30, ABMC 2017/038; 10 *Loxoconcha ovulata* (Costa, 1863), right valve, sample STZC 29, ABMC 2017/060; 11 *Loxoconcha ovulata* (Costa, 1863), juv, right valve, sample STZC 33, ABMC 2017/018; 12 *Loxoconcha gibberosa* Terquem, 1878, right valve, sample STZC 30, ABCM 2017/030; 13 *Cytheromorpha nana* Bonaduce, Ciampo and Masoli, 1976, left valve, sample STZC 28, ABMC 2017/069; 14 *Cytheromorpha nana* Bonaduce, Ciampo and Masoli, 1976, right valve, sample STZC 31, ABMC 2017/031; Scale bar 13, 14 – 50 µm;1-12 – 100 µm.

Section C from the sample STZC 19 to the uppermost level, with RA ranging from 0.85% to 15.46% (MNI) and from 0.9% to 14.29% (TNV).

Family LEPTOCYTHERIDAE Hanai, 1957
Genus LEPTOCYTHERE Sars, 1925
Leptocythere macella Ruggieri, 1975

1975 *Leptocythere macella* Ruggieri: p. 431, fig. 4.

1976a *Leptocythere macella* Ruggieri; Bonaduce, Ciampo and Masoli, pp. 32-33, pl. 18, figs. 1-5, text-figs. 12-15.

1988 *Leptocythere macella* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Leptocythere macella* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 483.

Distribution and remarks. Some poorly preserved shells of *L. macella,* an infralittoral-circalittoral species (Bonaduce et al., 1976a, 1977, 1988), occur in two samples of La Starza succession.

Leptocythere ramosa (Rome, 1942)
Figure 15.3

1942 *Cythere ramosa* Rome: p. 22, figs. 21-22; pl. 2, fig. 7.

1988 *Leptocythere ramosa* (Rome); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Leptocythere ramosa* (Rome); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 483.

2003 *Leptocythere ramosa* (Rome); Guernet, Lemeille, Sorel, Bourdillon, Berge-Thierry and Manakou, pp. 77, 79, pl. 1, figs. 3-4.

2015 *Leptocythere ramosa* (Rome); Frezza and Di Bella, pl. 1, figs. 1-2.

Distribution and remarks. An infra-circalittoral species (Guernet et al., 2003; Frezza and Di Bella, 2015) common at La Starza in Section C, showing a maximum RA of 19.38% (MNI).

Genus CALLISTOCYTHERE Ruggieri, 1953
Callistocythere badia (Norman, 1862)
Figure 15.4

1862 *Cythere badia* Norman: p. 48, pl. 3, figs. 13-15.

1977 *Callistocythere badia* (Norman); Athersuch and Whittaker, pp. 53-58.

1989 *Callistocythere badia* (Norman); Athersuch, Horne and Whittaker, pp. 110-111, pl. 2, fig. 5.

Distribution and remarks. The species, also cited as *C. folliculosa* Bonaduce, Ciampo and Masoli, 1976a, has been recorded in very shallow waters of the Eastern Atlantic and Mediterranean (Athersuch et al., 1989; Barra, 1997; Cabral and Loureiro, 2013). *C. badia* is uncommon at La Starza, occurring in seven samples of Section C with low RA.

Callistocythere flavidofusca (Ruggieri, 1950)
Figure 15.6-8

1950 *Leptocythere flavidofusca* Ruggieri: p. 46, pl. 1, figs. 6-7.

1976a *Callistocythere flavidofusca* (Ruggieri); Bonaduce, Ciampo and Masoli, p. 36, pl. 12, figs. 6-11.

1988 *Callistocythere flavidofusca* (Ruggieri); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Callistocythere flavidofusca* (Ruggieri); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

2008 *Callistocythere flavidofusca* (Ruggieri); Faranda and Gliozzi, p. 220, pl. 3, figs. 1-2.

Distribution and remarks. An upper shelf, mostly infralittoral, species, not recorded below 120 mbls (Bonaduce et al., 1976a, 1988). Present in Section C, relatively rare.

Callistocythere littoralis (Müller, 1894)
Figure 15.5

1894 *Cythere littoralis* sp. nov. Müller: p. 353, pl. 28, fig. 18.

1980 *Callistocythere littoralis* (Müller); Athersuch and Whittaker, pp. 61-66.

1988 *Callistocythere littoralis* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1989 *Callistocythere littoralis* (Müller); Athersuch, Horne and Whittaker, p. 108, fig. 41, pl. 2, fig. 4.

1990 *Callistocythere littoralis* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

Distribution and remarks. An infralittoral to upper circalittoral phytal species, occurring in Section C in two samples, with low RA values.

Family LOXOCONCHIDAE Sars, 1925
Genus LOXOCONCHA Sars, 1866
Loxoconcha gibberosa Terquem, 1878
Figure 15.12

1878 *Loxoconcha gibberosa* Terquem: p. 95, pl. 10, figs. 20a-e.

1976a *Loxoconcha gibberosa* Terquem; Bonaduce, Ciampo and Masoli, p. 108, pl. 64, figs. 1-7.

1988 *Loxoconcha gibberosa* Terquem; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Loxoconcha gibberosa* Terquem; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

2005 *Loxoconcha gibberosa* Terquem; Schneider, Witt and Yigitba?, p. 94, pl. 2, fig. 2.

Distribution and remarks. A shelf, mainly infralittoral species (Bonaduce et al., 1988; Aiello et al., 2006), very rare in the La Starza sediments, occurring only in the sample STZC 30 (MNI = 3.42%; TNV = 1.78%).

Loxoconcha ovulata (Costa, 1853)
Figure 15.9-11

1853c *Cythere ovulata* Costa: p. 181, pl. 16, fig. 7.

1979b *Loxoconcha ovulata* (Costa); Athersuch, pp. 141-150.

1988 *Loxoconcha tumida* Brady; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Loxoconcha tumida* Brady; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

Distribution and remarks. *L. ovulata* is a mainly infralittoral, subordinately upper circalittoral species (Barra, 1997; Aiello et al., 2006; Frezza and Di Bella, 2015), tolerant to stressed environment (Salvi et al., 2015) recorded both in Sections B and C (MNI = from 0.48% to 18.60%; TNV = from 0.40% to 17.12%).

Genus CYTHEROMORPHA Hirschmann, 1909
Cytheromorpha nana Bonaduce, Ciampo and Masoli, 1976
Figure 15.13-14

1976a *Cytheromorpha nana* Bonaduce, Ciampo and Masoli: p. 114, pl. 70, figs. 9-11.

Distribution and remarks. *C. nana* has been recorded in the depth range 19-111 mbsl (Bonaduce et al., 1976a). Uncommon at La Starza is present in six samples with a maximum RA of 2.77% (MNI).

Genus ELOFSONIA Wagner, 1957
"Elofsonia" minima (Bonaduce, Ciampo and Masoli, 1976)
Figure 16.1-2

1976a «*Bythocythere minima*» Bonaduce, Ciampo and Masoli: pp. 114-115, pl. 78, figs. 7-11.

1988 *Bythocythere minima* Bonaduce, Ciampo and Masoli; Bonaduce, Masoli and Pugliese, p. 455.

1988 «*Bythocythere minima*» Bonaduce, Ciampo and Masoli; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 «*Bythocythere minima*» Bonaduce, Ciampo and Masoli; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 483.

2006 *"Elofsonia" minima* (Bonaduce, Ciampo and Masoli); Aiello, Barra, Coppa, Valente and Zeni, tab. 3.

Distribution and remarks. An infralittoral species (Bonaduce et al., 1976a; Bonaduce et al., 1988; Aiello et al., 2006) present at La Starza in three samples, with RA ranging from 0.24%-2.77% (MNI) and from 0.60% to 0.81% (TNV). Some valves fit well with the original figures (Figure 16.1) whereas other specimens show a slightly different outline and ornamentation (Figure 16.2) maybe due to sexual dimorphism. Since intraspecific variability of this species is barely documented in literature, we have assigned all this forms to *"Elofsonia" minima*, aware of the need of well preserved material to define its taxonomy.

Genus PALMOCONCHA Swain and Gilby, 1974
Palmoconcha turbida (Müller, 1912)
Figure 16.3

1912 *Loxoconcha turbida* Müller: p. 308.

2015 *Palmoconcha turbida* (Müller); Frezza and Di Bella, pl. 1, figs. 15-16.

Distribution and remarks. A shelf species, tolerant to low oxic waters (Bodergat et al., 1998), mainly living in infralittoral and upper circalittoral waters (Bonaduce et al., 1977; Frezza and Di Bella, 2015). At La Starza it has been recorded in Section C from the sample 20 to the sample 32 with a RA ranging from 1.75% to 8.30% (MNI) and from 1.19% to 5.5% (TNV).

Genus SAGMATOCYTHERE Athersuch, 1976
Sagmatocythere versicolor (Müller, 1894)
Figure 16.4-5

1894 *Loxoconcha versicolor* Müller: p. 346, pl. 27, fig. 4; pl. 28, figs. 5, 10.

1976a *Loxoconcha versicolor* Müller; Bonaduce, Ciampo and Masoli, p. 111, pl. 65, figs. 1-8.

1988 *Loxoconcha versicolor* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Loxoconcha versicolor* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

2008 *Sagmatocythere versicolor* (Müller); Faranda and Gliozzi, p. 223, pl. 9, fig. 13.

Distribution and remarks. A shelf species generally showing its maximum abundance in lower infralittoral - upper circalittoral zone (Bonaduce et al., 1976a, 1977, 1988; Aiello et al., 2006; Frezza and Di Bella, 2015). At La Starza *S. versicolor* is

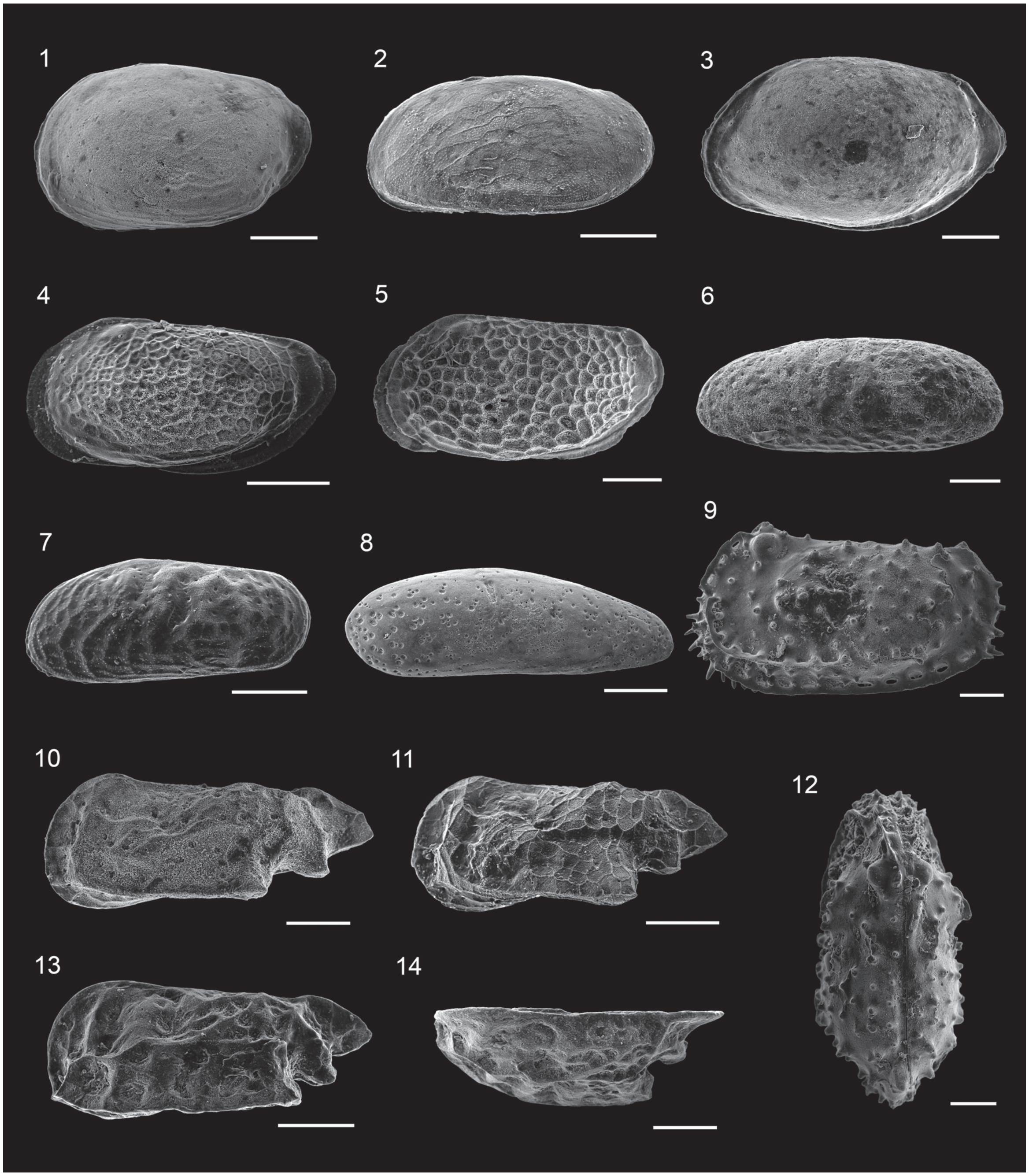

FIGURE 16. 1 *"Elofsonia" minima* (Bonaduce, Ciampo and Masoli, 1976), left valve, female, sample STZC 27, ABMC 2017/075; 2 *"Elofsonia" minima* (Bonaduce, Ciampo and Masoli, 1976), left valve, male, sample STZC 28, ABMC 2017/066; 3 *Palmoconcha turbida* (Müller, 1912), left valve, sample STZC 27, ABMC 2017/032; 4 *Sagmatocythere versicolor* (Müller, 1894), juv, left valve, sample STZC 28, ABMC 2017/081; 5 *Sagmatocythere versicolor* (Müller, 1894), left valve, sample STZC 33, ABMC 2017/085; 6 *Procytherideis retifera* Ruggieri, 1978, left valve, sample STZC 29, ABMC 2017/063; 7 *Procytherideis subspiralis* (Brady, Crosskey and Robinson, 1874), left valve, sample STZC 33, ABMC 2017/079; 8 *Sahnicythere retroflexa* (Klie, 1936), right valve, sample STZC 33, ABMC 2017/065; 9 *Carinocythereis whitei* (Baird, 1850), left valve, sample STZC 31, ABMC 2017/046; 10 *Paracytheridea paulii* Dubowsky, 1939, left valve, sample STZC 32, ABMC 2017/026; 11 *Paracytheridea paulii* Dubowsky, 1939, left valve, sample STZC 26, ABMC 2017/080; 12 *Carinocythereis whitei* (Baird, 1850), carapace in dorsal view, sample STZC 28, ABMC 2017/071; 13 *Paracytheridea triquetra* (Reuss, 1850), left valve, sample STZC 29, ABMC 2017/022; 14 *Paracytheridea triquetra* (Reuss, 1850), left valve in dorsal view, sample STZC 29, ABMC 2017/022; Scale bar 100 μm.

present in scattered samples of Section C with maximum RA of 5.54% (MNI).

Family NEOCYTHERIDEIDAE Puri, 1957
Genus PROCYTHERIDEIS Ruggieri, 1978
Procytherideis retifera Ruggieri, 1978
Figure 16.6

1978 *Procytherideis retifera* Ruggieri: p. 10.
1976a *Neocytherideis* sp. 1 Bonaduce, Ciampo and Masoli: p. 62, pl. 36, figs. 5-11.
1997 *Procytherideis retifera* Ruggieri; Barra, p. 78, pl. 2, fig. 3.
1988 *Procytherideis retifera* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.
1990 *Procytherideis retifera* Ruggieri; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.
2008 *Procytherideis retifera* Ruggieri; Faranda and Gliozzi, pl. 2, figs. 1-2.

Distribution and remarks. *Procytherideis retifera* is an infralittoral species (Bonaduce et al., 1976a; Barra, 1997) uncommon in the studied assemblages, occurring in three samples of Section C with a maximum RA of 5.50% (MNI).

Procytherideis subspiralis (Brady, Crosskey and Robinson, 1874)
Figure 16.7

1874 *Cytherideis subspiralis* Brady, Crosskey and Robinson: p. 211, pl. 10, figs. 16-17.
1976a *Neocytherideis subspiralis* (Brady, Crosskey and Robinson); Bonaduce, Ciampo and Masoli, pp. 62-63, pl. 35, figs. 11-14.
1988 *Neocytherideis subspiralis* (Brady, Crosskey and Robinson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.
1990 *Neocytherideis subspiralis* (Brady, Crosskey and Robinson); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 483.
2004 *Procytherideis subspiralis* (Brady, Crosskey and Robinson); Bonaduce and McKenzie, pp. 105, 107, text figs. 3A-H.

Distribution and remarks. Only few juvenile specimens of this upper circalittoral species (Bonaduce et al., 1976a) have been found in the sample STZC 33.

Genus SAHNICYTHERE Athersuch, 1982
Sahnicythere retroflexa (Klie, 1936)
Figure 16.8

1936 *Cytherideis retroflexa* Klie: p. 52 figs. 4-11.
1988 *Sahnia subulata* (Brady); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.
1990 *Sahnia subulata* (Brady); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.
1989 *Sahnicythere retroflexa* (Klie); Athersuch, Horne and Whittaker, p. 128, text-fig. 49; pl. 3, fig. 8.

Distribution and remarks. *Sahnicythere retroflexa* generally occurs in the infralittoral zone (Bonaduce et al., 1976a, as *Sahnia subulata*; Athersuch et al., 1989; Mangoni et al., 2016). It is rare at La Starza, some valves occurring only in the sample STZC 33.

Family PARACYTHERIDEIDAE Puri, 1957
Genus PARACYTHERIDEA Müller, 1894
Paracytheridea paulii Dubowsky, 1939
Figure 16.10-11

1939 *Paracytheridea paulii* Dubowski: p. 52, figs. 15-18.
1969 *Paracytheridea paulii* Dubowski; Schornikov, p. 202, pl. 29, fig. 1.
1971 *Paracytheridea parallia* var. A; Barbeito-Gonzalez, pl. 28, figs. 5c-6c.

Distribution and remarks. The present is the first fossil record of this infralittoral (Barbeito-Gonzalez, 1971) species rarely recorded in the Mediterranean. Uncommon in the La Starza succession.

Paracytheridea triquetra (Reuss, 1850)
Figure 16.13-14

1850b *Cypridina triquetra* Reuss: p. 82, pl. 10, fig. 19.
2004 *Paracytheridea triquetra* (Reuss); Aiello and Szczechura, p. 39, pl. 8, fig. 16.

Distribution and remarks. *Paracytheridea triquetra* is a species characteristic of the European Neogene shallow waters (Aiello and Szczechura, 2004); it occurs in the sediments of Section C, relatively rare.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
Genus ACANTHOCYTHEREIS Howe, 1963
Acantocythereis histryx (Reuss, 1850)

1850b *Cypridina hystrix* Reuss: p. 74, pl. 10, figs. 6a-c.
1979a *Acantocythereis histryx* (Reuss); Athersuch, pp. 133-140.

Distribution and remarks. *Acantocythereis hystrix* is a shelf species mainly recorded in the circalittoral zone of the Adriatic Sea (Bonaduce et al., 1976a; Breman, 1976) and in the upper infralittoral-paralic of the eastern Mediterranean (Kubanç, 2005). The specimens recorded in some samples of Sections B and C are poorly preserved.

Genus CARINOCYTHEREIS Ruggieri, 1956
Carinocythereis whitei (Baird, 1850)
Figure 16.9, 16.12

1850 *Cythereis Whitei* sp. nov. Baird: p. 175, pl. 20, figs. 3-3a.

1964 *Carinocythereis quadridentata* (Baird); Rodriquez, p. 113, pl. 6, fig. I.4.

1987 *Carinocythereis whitei* (Baird); Athersuch and Whittaker, pp. 103-110.

1988 *Carinocythereis antiquata* (Baird); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1989 *Carinocythereis whitei* (Baird); Athersuch, Horne and Whittaker, p. 137, fig. 54; pl. 4, fig. 2.

1990 *Carinocythereis antiquata* (Baird); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

Distribution and remarks. *Carinocythereis whitei* has been recorded in the infralittoral - upper circalittoral zone, mostly in the depth range 0-60 m on silty-sandy bottom sediments (Athersuch et al., 1989; Aiello et al., 2006). Common at La Starza in Section C, reaching a RA peak of 34.07% (MNI).

Genus CISTACYTHEREIS Uliczny, 1969
Cistacythereis (*Hiltermannicythere*) *turbida* (Müller, 1894)
Figure 17.5-6

1894 *Cythereis turbida* Müller: p. 371, pl. 28, figs. 22, 27; pl. 31, fig. 7.

1976a *Hiltermannicythere turbida* (Müller); Bonaduce, Ciampo and Masoli, pp. 49-50, pl. 24, figs. 7-9.

1988 *Hiltermannicythere turbida* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Hiltermannicythere turbida* (Müller); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485.

2006 *Cistacythereis* (*Hiltermannicythere*) *turbida* (Müller); Aiello, Barra, Coppa, Valente and Zeni, tab. 3.

Distribution and remarks. A shelf species recorded from the upper infralittoral (Aiello et al., 2006) to the lower circalittoral, with an optimum in the depth range 27-125 mbsl (Bonaduce et al., 1977). It is present in the majority of the samples of Section C, with maximum RA of 19.32% (MNI).

Genus COSTA Neviani, 1928
Costa edwardsii (Roemer, 1838)
Figure 17.1-4

1838b *Cytherina edwardsii* Roemer: p. 518, pl. 6, fig. 27.

1988 *Costa edwardsii* (Roemer); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Costa edwardsii* (Roemer); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 483, 485, pl. 5, fig. 5.

2006 *Costa edwardsii* (Roemer); Mostafawi and Matzke-Karasz, pp. 16, 18, pl. 1, figs. 6-7.

2008 *Costa edwardsii* (Roemer); Faranda and Gliozzi, pp. 234-235, pl. 6, figs. 1, 4, 7, 10.

Distribution and remarks. This species, also reported as *C. runcinata* (Baird, 1850), lives in lower infralittoral to lower circalittoral waters, being very rare above 20 mbsl. It shows its optimum in the upper circalittoral zone (~40-100 mbsl) (Bonaduce et al., 1976a; Breman, 1976; Lachenal, 1989; Mostafawi and Matzke-Karasz, 2006).

Costa edwardsii is one of the characteristic species of the ostracod assemblages of the La Starza succession, ranging in the Section C from 4.60% to 58.25% (MNI) and from 9.64% to 53.61% (TNV); it shows its maximum RA value in Section B, with 78.63% (TNV). The distribution of *C. edwardsii* in Section C suggests its tolerance to phases of stressed physico-chemical bottom water conditions.

Genus PTERYGOCYTHEREIS Blake, 1933
Pterygocythereis coronata (Roemer, 1838)

1838b *Cytherina coronata* Roemer: p. 518, pl. 6, fig. 30.

1988 *Pterygocythereis siveteri* Athersuch; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Pterygocythereis siveteri* Athersuch; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

2008 *Pterygocythereis coronata* (Roemer); Faranda and Gliozzi, p. 238, pl. 7, fig. 1.

Distribution and remarks. A lower infralittoral and upper circalittoral species frequently recorded as *P. ceratoptera* (Bosquet, 1852) and *P. siveteri* Athersuch, 1978a (Bonaduce et al., 1976a, 1977; Faranda and Gliozzi, 2008). Relatively common in the La Starza assemblages, with a maximum RA of 26.05% (TNV).

Pterygocythereis jonesii (Baird, 1850)
Figure 17.7-8

1850 *Cythereis Jonesii* Baird: p. 175, pl. 20, fig. 1.

1964 *Pterygocythereis jonesii* (Baird); Rodriquez, p. 113, pl. 6, fig. I.7.

1978b *Pterygocythereis jonesii* (Baird); Athersuch, pp. 9-16.

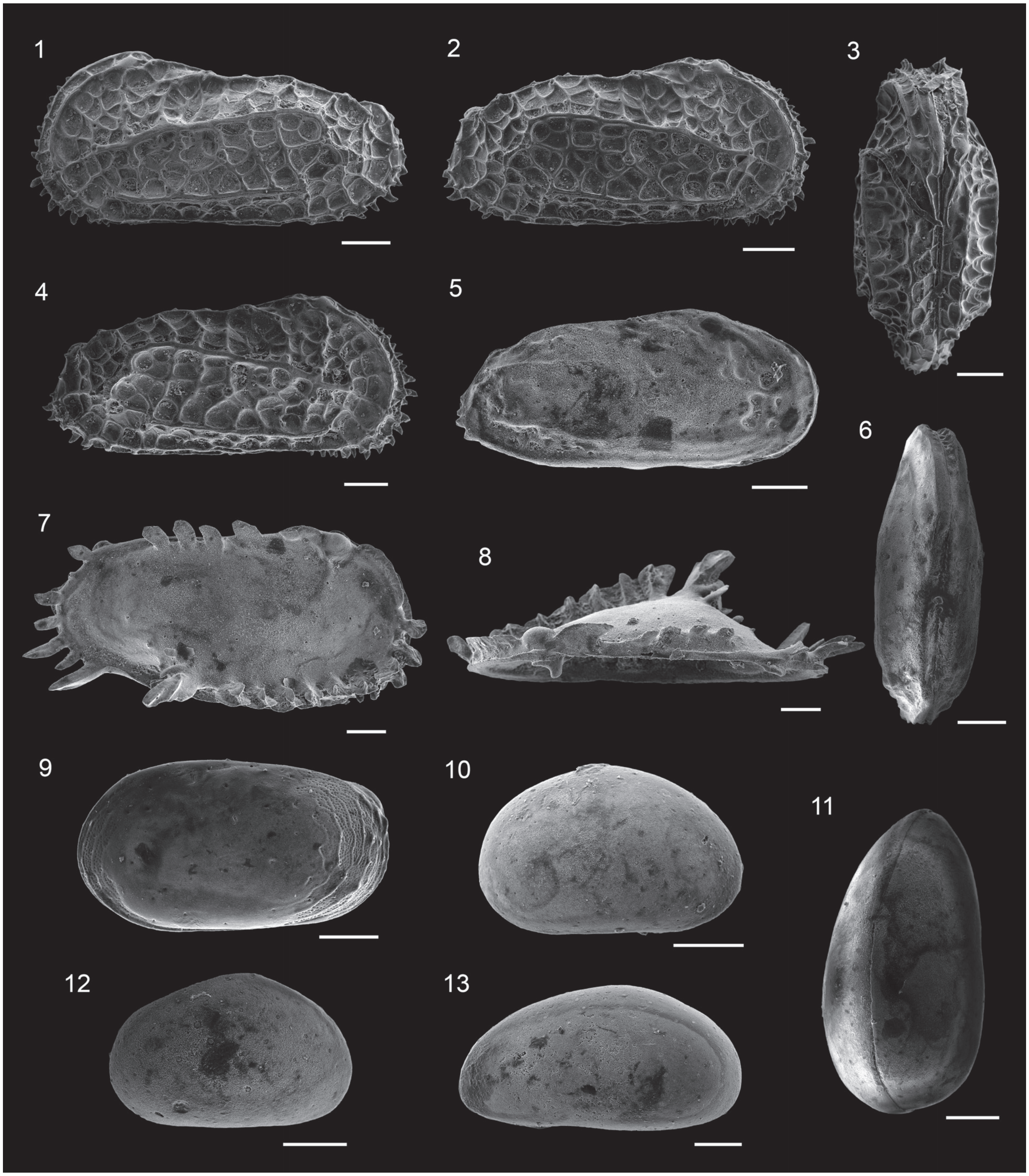

FIGURE 17. 1 *Costa edwardsii* (Roemer, 1838), left valve, sample STZC 19, ABMC 2017/042; 2 *Costa edwardsii* (Roemer, 1838), right valve, sample STZC 22, ABMC 2017/052; 3 *Costa edwardsii* (Roemer, 1838), carapace in dorsal view, sample STZC 19, ABMC 2017/073; 4 *Costa edwardsii* (Roemer, 1838), right valve, sample STZC 28, ABMC 2017/090; 5 *Cistacythereis* (*Hiltermannicythere*) *turbida* (Müller, 1894), right valve, sample STZC 25, ABMC 2017/021; 6 *Cistacythereis* (*Hiltermannicythere*) *turbida* (Müller, 1894), carapace in dorsal view, sample STZC 26, ABMC 2017/027; 7 *Pterygocythereis jonesii* (Baird, 1850), right valve, sample STZC 34, ABMC 2017/023; 8 *Pterygocythereis jonesii* (Baird, 1850), right valve in dorsal view, sample STZC 34, ABMC 2017/028; 9 *Rectobuntonia subulata* (Ruggieri, 1954), left valve, sample STZC 33, ABMC 2017/029; 10 *Xestoleberis communis* Müller, 1894, right valve, sample STZC 27, ABMC 2017/064; 11 *Xestoleberis dispar* Müller, 1894, carapace in dorsal view, sample STZC 22, ABMC 2017/040; 12 *Xestoleberis* ? *rara* Müller, 1894, right valve, sample STZC 27, ABMC 2017/087; 13 *Xestoleberis dispar* Müller, 1894, left valve, sample STZC 21, ABMC 2017/037; Scale bar 100 μm.

1988 *Pterygocythereis jonesii* (Baird); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Pterygocythereis jonesii* (Baird); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

2004 *Pterygocythereis jonesii* (Baird); Aiello and Szczechura, pp. 27-28, pl. 5, fig. 8.

Distribution and remarks. *Pterygocythereis jonesii* is a shelf species (extensive literature in Aiello and Szczechura, 2004), not rare at La Starza in Sections B and C. In the sample STZC 16 the ostracod assemblage consists of two valves of *P. jonesii.* RA (except sample STZC 16) ranges from 0.85 to 10.80% (MNI) and from 0.41 to 22.60% (TNV).

Genus RECTOBUNTONIA Sissingh, 1972
Rectobuntonia subulata (Ruggieri, 1954)
Figure 17.9

1954 *Buntonia subulata* Ruggieri: p. 568, figs. 34-37.

1976b *Buntonia subulata* Ruggieri; Bonaduce, Pugliese and Minichelli, pp. 429-432, figs. 1a-1g, figs. 2.1-2.3.

1988 *Rectobuntonia subulata* (Ruggieri); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 976.

1990 *Rectobuntonia subulata* (Ruggieri); Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484-485, pl. 4, fig. 2.

2004 *Rectobuntonia subulata (*Ruggieri); Bonaduce and McKenzie, pp. 103, 105; text-figs. 2 H-R.

Distribution and remarks. This species, uncommon in lower infralittoral and lower circalittoral waters, shows its optimum in the upper circalittoral zone (Schornikov, 1969; Bonaduce et al., 1976b, 1977, 1988; Yassini, 1979). At La Starza has been recorded in ten samples of Section C from the sample STZC 17 to STZC 34, with low RA values.

Family XESTOLEBERIDIDAE Sars, 1928
Genus XESTOLEBERIS Sars, 1866
Xestoleberis communis Müller, 1894
Figure 17.10

1894 *Xestoleberis communis* Müller: p. 338, pl. 25, figs. 32-33, 39, pl. 10, figs. 78-83.

1978c *Xestoleberis communis* Müller; Athersuch, p. 296, pl. 9, figs. 1-4; pl. 10, figs. 1, 3-5; pl. 17, fig. 8; text-figs. 5b, d, 8c, 10b-c.

1988 *Xestoleberis communis* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Xestoleberis communis* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 484.

1997 *Xestoleberis communis* Müller; Barra, p. 87, pl. 6, fig. 1.

Distribution and remarks. *Xestoleberis communis* is widely distributed in the infralittoral and upper circalittoral Mediterranean waters (Frezza and Di Bella, 2015). The shells recovered in Section C deposits pertain mainly to young instars; RA values generally low.

Xestoleberis dispar Müller, 1894
Figure 17.11, 17.13

1894 *Xestoleberis dispar* Müller: p. 334, pl. 25, figs. 2-3, 9, 35.

1976a *Xestoleberis dispar* Müller; Bonaduce, Ciampo and Masoli, p. 124, pl. 73, figs. 1-3.

1988 *Xestoleberis dispar* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, p. 977.

1990 *Xestoleberis dispar* Müller; Amore, Barra, Ciampo, Ruggiero Taddei, Russo and Sgarrella, pp. 484-485.

1997 *Xestoleberis dispar* Müller; Barra, p. 87, pl. 7, figs. 7-8.

Distribution and remarks. An infralittoral and, subordinately, upper circalittoral species (Bonaduce et al., 1976a, 1977, 1988) not rare in the main part of the fossiliferous samples at La Starza, with a maximum RA of 14.81%.

DISCUSSION

In an environmental context under the influence of volcanic activities both paleodepth trends and the physico-chemical characteristics of paleobottom waters can show remarkable variations over a relatively brief time span and in limited areas, as shown, for example, by the events linked to the 1538 CE eruption at Monte Nuovo (Di Vito et al., 2016). Previously, Amore et al. (1988, 1990) investigated the paleoenvironmental characteristics of the sediments of two sections (Proprietà Sersale and Proprietà Fusco) on the basis of the foraminiferal, ostracod and macrobenthic assemblages. Amore et al. (1988) divided the succession into three intervals: the lower part possibly deposited in the depth range 10–20 m, the middle one with a paleodepth of 15–20 m, and the upper interval showing a transgressive trend from lower infralittoral (20–30 m) to upper circalittoral zone (40–50 m). In Amore et al. (1990) one foraminifer and one ostracod new species were described and paleoenvironmental features, with special regards to bottom water conditions, are discussed, confirming the paleobathymetric evaluations of Amore et al. (1988) and suggesting a depositional environment characterized by low pH waters. Ciampo (2004) tested on the same material a method of paleobathymetric reconstruction based on the comparison between the percentage species composition of fossil ostracod assemblages and polynomial patterns of depth distribution data of the species in the Mediterranean. The author analyzed four samples of the Fusco Section and one sample of the Sersale Section, with an inferred paleobathymetry ranging from 10.5 to 47.8 m.

Data presented herein show that the discontinuous volcanic activity in the Campi Flegrei caldera and the related ground deformations in the area of La Starza were characterized by multiple subsidence and uplift events, conditioning the composition of the Holocene meiofaunal assemblages. Benthic foraminiferal and ostracod assemblages exhibit very different compositions in approximately coeval intervals of the study sections because of different physico-chemical conditions in a small area. This is most likely due to the presence of a paleo-hydrothermal system comparable to the shallow ventings reported in the Tyrrhenian Sea and characterized by formation of acidic waters (Dando et al., 1999; Hall-Spencer et al., 2008; Boatta et al., 2013; Ingrassia et al., 2015a; b).

In the La Starza succession the state of preservation of fossil remains is moderately good in some samples and poor in others. As previously stated a number of assemblages consist exclusively of siliceous remains, and miliolids are very rare. These data suggest the presence of waters undersaturated in $CaCO_3$ at different degrees during the deposition of the succession. Marine waters in volcanic environments may be strongly influenced by deposition of volcanic ashes, erosion of volcanic soils and especially volcanic vents or cold seeps activity (Frogner et al., 2001; Kiel, 2010; Wall-Palmer et al., 2011). These factors may alter the physico-chemical parameters of the bottom sediments and waters due to the release of free gas, (mainly carbon dioxide, nitrogen, methane, sulphur dioxide, hydrogen sulphide, hydrogen), to increased temperature, high concentration of heavy metals and decreased pH, resulting toxic to organisms (Dando, 2010; v. therein for extensive references). Shallow marine hydrothermal vent systems are frequently characterized by biota, such as nematodes and polychaetes, devoid of easily fossilizable parts, able to live in extreme ecological conditions where macrofauna is not present (Kamenev et al., 1993; Hoaki et al., 1995). As a general rule in the vicinity of the vent outlets the diversity decreases, the dominance of tolerant species increases (Melwani and Kim, 2008; Zeppilli and Danovaro, 2009; Karlen et al., 2010; Chan et al., 2016) and the bottom waters are frequently corrosive to calcium carbonate inhibiting the calcification of shelled organisms (Cigliano et al., 2010; Ricevuto et al., 2012; Boatta et al., 2013).

Previous investigations on benthic foraminifers in Tyrrhenian vent systems provide information allowing a comparison between living-subrecent and fossil assemblages; on the other hand, ostracod data are very limited. The species able to tolerate the higher hydrothermal stress, including low pH bottom waters, mainly pertain to agglutinated taxa (Panieri, 2006; Dias et al., 2010; Di Bella et al., 2016) that are not recorded in the La Starza succession. All studied sections display both barren marine sediments and deposits devoid of calcareous fossils, possibly testifying persisting acidic conditions or toxic phases including CO_2 emissions, with pH values lower than 7.6-7.9 (Dias et al., 2010; Uthicke et al., 2013; Pettit, 2015). The presence of siliceous microfossils suggests some resemblances with environments dominated by siliceous sponges described by Tarasov et al. (1999). As previously recorded in the Pleistocene of the Procida Island (Aiello et al., 2007; Aiello et al., 2012) and in the Recent (Di Bella et al., 2016) the calcareous assemblages of La Starza include very rare specimens of miliolids, suggesting deposition in waters with pH values lower than 8.14 (Dias et al., 2010).

Shallow marine hydrothermal environments characterised by dominant *P. oceanica*, have been described from the Ischia Island, where hydrogen sulphide is not present (Hall-Spencer et al., 2008). This species is a seagrass which tolerates moderate levels of hydrothermal emissions (Aliani et al., 1998; Dando, 2010), is sensitive to intense degassing episodes (Panieri, 2006) and especially to sulphide emissions (Garcias-Bonet et al., 2008). Hall-Spencer et al. (2008) described an environmental context showing remarkable affinities with the features recorded at La Starza in the substage g1, where rhizomes of *P. oceanica* occur in six sections alternating with both fossiliferous and barren layers.

Panieri et al. (2005) reported an unusual occurrence of *P. oceanica* meadows at a water depth of about 80 m in Secca dei Pesci, a site characterized by low-temperature emissions. Foraminiferal assemblages are dominated by *Cibicides lobatulus*, *Asterigerinata mamilla*, *Reussella spinulosa*, *Globocassidulina subglobosa* and *Elphidium complanatum.* These species are well represented in the La Starza sediments, where generally the dominant genera are *Ammonia* and *Elphidium*, a difference due, in our opinion, to different deposition depth.

The analysis of the microfossil remains and the comparison with the stratigraphic and sedimentary features of the succession allowed the discrimination of eight stages (a-h) and the reconstruction of paleoenvironmental trends (Figure 7).

The level of detail of the paleoecological reconstruction depends on the foraminiferal and ostracod assemblages. The presence and state of preservation of calcareous microfossils in a volcanic environment are linked to physico-chemical conditions of the bottom waters. If they are strongly undersaturated in $CaCO_3$ only siliceous remains can be preserved. In some levels of the succession of La Starza well-preserved benthic foraminiferal and ostracod assemblages allowed to reconstruct variations in paleobathymetry ranging from upper infralittoral to upper circalittoral zone.

Stages

Stage a. The lowermost interval is part of the Epoch I of volcanic activity of Campi Flegrei (15-10.6 k.y.a) and comprises the oldest of the studied sediments, recovered in the Tunnel Section, including only the sample Tun 1. The sedimentological features of the beds of fine-medium sands and coarser sediments suggest a deposition in the wetted-subaerial part of a washover fan, in the supralittoral zone.

Stage b. This stage is represented by sediments deposited during the upper part of the Epoch I that includes two levels that provide mean ages of 11.23 and 10.46 k.y.a, respectively (Figure 2). Samples pertaining to this interval are: Tun 2-15; STZD 1-2; STZC 1-5; STZE 1. Within Stage b barren sediments prevail. Sandy beds with cross-laminated and wedge-shaped bed-set packages sedimentary structures suggest a mediolittoral - upper infralittoral zone, characterized by bar and trough systems, below the low tide level or in rip channels due to longshore currents or waves action, in low pH waters. The uppermost level (sample STZE 1) yielded assemblages showing moderately stressed bottom waters, in lower infralittoral paleoenvironment, with unfavourable conditions for ostracods. The high RA of the species *C. edwardsii* (>38%) is possibly due to its tolerance to environmental stress.

Stage c. The alternations of fine to coarse sediments of Stage c, deposited during the quiescence period (10.6-9.6 k.y.a) following Epoch I, and during the beginning of the Epoch II, include the samples Tun 16-19, STZB 1 and STZC 6-12. They are mainly devoid of microfossils, except STZC 7 and STZC 9. Fossil content, consisting of siliceous remains and, in the sample STZC 7, of a single test of *E. granosum*, and sedimentological characteristics suggest a marginal to upper infralittoral marine paleoenvironment, undersaturated in $CaCO_3$, under unfavourable physico-chemical conditions.

Stage d. This stage corresponds with the upper part of Epoch II. Samples Tun 20-22, STZB 2-3 and STZC 13-16 have been collected within this interval. Assemblages are largely dominated by siliceous microfossils, except the sample STZC 13, which contains benthic foraminifers, and the samples STZC 15-16 where both ostracod and foraminiferal remains occur. The inferred paleoenvironment ranges from mediolittoral to upper infralittoral zone, in marine very low to moderately low pH waters. The CFRA values vary from 22.02% (STZC 15) to 0% (STZC 16) suggesting a regressive trend, culminating in the emersion episode of the following stage.

Stage e. It corresponds to an emersion phase occurred at ~9.1 k.y.a, testified by an orange brown pedogenised level (no samples collected in this layer).

The following two intervals (stage f and substage g1) represent the rest phase between Epoch II and Epoch III, in the time range ~9.1 to ~5.5 k.y.a.

Stage f. In this interval the following samples have been collected: STZB 4-9, STZC 17-26, STZE 2-4, STZF 1. A level belonging to the lower part of this stage (Figure 2) provided a mean age of ~8.6 k.y.a. Assemblages testify the beginning of a trangressive phase at about 8.5 k.y.a. The assemblages of Stage f show different compositions and state of preservation in various sections. In the section B the samples STZB 4, STZB 7-9 yielded assemblages consisting mainly of siliceous microfossils suggesting a marine paleoenvironment with low pH waters. In the samples STZB 5-6 benthic foraminiferal and ostracods assemblages confirm the transgressive trend from infralittoral to upper circalittoral zone. CFRA reaches 20.7% in the sample STZB 5 and 30.89% in the sample STZB 6, whereas CORA is 15.38% (MNI) and 16.81% (TNV) in STZB 5 and 80.49% (MNI) and 88.89% (TNV) in STZB 6.

In the lowermost sample of this stage in the Section C (STZC 17), circalittoral foraminifers are not present (CFRA=0), indicating an upper infralittoral paleonvironment. In the following samples

(STZC 18-19) a rapid increase of paleodepth is documented, with deposition in upper circalittoral waters with high values of CFRA and CORA [STZC 18: CFRA=25.69%; CORA=89.32% (MNI) and 86.67% (TNV). STZC 19: CFRA=25.66%, CORA=55.40% (MNI) and 68.07% (TNV)]. High values of TFRA (STZC 18=60.93%; STZC 19=46.90%) and AE (STZC 18=31.61; STZC 19=35.90) indicate possibly low oxygen bottom waters.

Assemblages of the samples STZC 20-26, making up the subcluster B2, suggest a persisting upper circalittoral (CFRA ranges from 21.67% to 36.94%, CORA (MNI) from 15.94% to 28.99%, CORA (TNV) from 15.66% to 51.87%), moderately stressed, paleoenvironment.

The benthic foraminiferal assemblage of the sample STZE 2 shows a medium-low CFRA (16.48%), probably representing an intermediate paleodepth, in lower infralittoral zone, between the samples STZC 17 and STZC 18 during the early Stage f trangression. The lack of foraminiferal and ostracod remains of the samples STZE 3-5 suggests the variability of sedimentary and/or post-sedimentary physico-chemical conditions in the complex depositional system of the Campi Flegrei caldera.

The benthic foraminiferal assemblage of the sample STZF 1, belonging to the upper part of Stage f, suggests a deposition in lower infralittoral - upper circalittoral zone (CFRA=19.8%), in environmental conditions unfavourable for ostracod life.

Stage g. The stage has been split in two substages. The first one, substage g1, starts slightly before the level dated to ~5.86 k.y.a and includes the upper part of the quiescent period between Epoch II and Epoch III. The boundary between substages g1 and g2, separated by an erosional surface, corresponds to the beginning of Epoch III at ~5.5 k.y.a. Stage g ends with the Cigliano volcanic deposits (mean age=5.247 k.y.a). Substage g1 includes the samples: Tun 23-30, STZA 1-6, STZB 10, STZC 27-35, STZE 5-9 and STZF 2-4. In the Tunnel Section and in the sections A, B, C, E and F the substage g1 is marked by levels with rhizomes of *P. oceanica*, a seagrass species characteristic of the infralittoral zone of the Mediterranean, presently reaching a maximum depth of ~50 mbsl (Boudouresque et al., 2006). The deposits of the Tunnel Section, STZA, STZB and STZE suggest a stressed marine paleoenvironment where calcareous remains are very rare or lacking. The assemblages of the Section C show that this substage is characterized by moderate paleobathymetric fluctuations, ranging from lower infralittoral to the uppermost part of the circalittoral zone (STZC 27-34: CORA (MNI)= from 8.14% to 45.34%; CORA (TNV): from 13.51% to 50.68%; CFRA: from 16.41% to 25.5%). The samples STZF 2-4 are deposited in a deepening phase where CFRA=0% in the lower sample (STZF 2) and increase in STFZ 3 (CFRA=7.69%) and STZF 4 (CFRA=20.27%); in this last sample ostracods are present and the circalittoral species *C. edwardsii* is well represented. The uppermost sample of Section C (STZC 35), belonging to the substage g1, yielded only siliceous remains, suggesting a new episode of marine waters undersaturated in $CaCO_3$.

In the second substage (g2) only the sample Tun 35 is fossiliferous, showing a marine paleoenvironment in low pH waters (paleodepth not detectable).

Stage h. All the sediments belonging to this interval are barren, and the paleoenvironmental variations showed in Figure 7 are based on the sedimentary features of the sandy layers of the Pozzuoli unit sampled in the Tunnel Section (Tun 36-38) and in the Section A (STZC 12). A marine paleoenvironment (paleodepth not detectable) is supported by the record of rare and poorly preserved echinoid and bryozoans remains in similar deposits collected in the same area (Isaia, Aiello and Barra, pers. obs.).

CONCLUSIONS

The La Starza outcrops represent a sedimentary complex deposited in a late Quaternary caldera during a time span of about 8 ka. The interplay between sea level variations and subsidence-uplift episodes linked to volcanic activities originated alternating marine trangressions and regressions, as shown by the composition of meiofaunal assemblages. They consist of infralittoral and upper circalittoral taxa commonly recorded in the recent Mediterranean waters, exhibiting a number of peculiarities. Actually, benthic foraminiferal and ostracod assemblages are characterized by the lack, or very low relative abundance, of taxa sensitive to stressed environmental conditions and by high mean relative abundances of some stress-tolerant species.

The comparison of the calcareous remains of La Starza terrace and the thanatocoenosis of the infralittoral and upper circalittoral bottom sediments of the nearby coastal areas of Monte di Procida (Mangoni et al., 2016) and of the Gulf of Pozzuoli (Aiello, Barra and Parisi, pers. obs.) highlights some differences between Holocene and Recentsubrecent assemblages. The fossil benthic foraminifers display higher relative abundances of *Haynesina* spp. and *Nonionella turgida*, well-known stress-tolerant taxa; *Elphidium* spp. show very high percentage values; conversely, miliolids, which are dominant in Recent assemblages, are almost completely lacking. In the ostracod assemblages of La Starza we have observed an unusual abundance of trachyleberidid genera and the absence, or scanty occurrence, of some species such as *Aurila convexa*, *Neocytherideis muelleri*, and *Sahnicythere retroflexa* generally well-represented in the infralittoral and upper circalittoral zone of this area.

A paleoenvironmental model under the persisting influence of volcanic vents with rapid variations of hydrothermal emissions, varying in limited areas, seems to fit adequately with the paleontological and sedimentary characters of the La Starza succession, exhibiting notable similarities with Recent vent systems described from the Tyrrhenian Sea.

Generally, abundance and diversity of taxa with calcareous hard-parts decrease in the proximity of hydrothermal vent, where pH and calcium carbonate saturation may be low and pCO_2 high (Martin et al., 2008; Cigliano et al., 2010; Dias et al., 2010; Pettit, 2015).

The very rare findings of miliolids at la Starza fit well with the observations of Dias et al. (2010) on the assemblages occurring in the infralittoral waters of Ischia, showing that in normal conditions (pH 8.2-8.14) the porcelaneous foraminifers are abundant, whereas they are not recorded in waters with medium and low pH (7.8-7.6) near the CO_2 seeps. They are rare in the Zannone Giant Pockmark (Di Bella et al., 2016) and very rare in Panarea waters (Panieri, 2006). The sensitivity of miliolids to acidic environment has been attributed to their high-Mg calcite test; on the other hand the remarkable high relative abundances of the genus *Elphidium* in the La Starza assemblages can be related with their tolerance to low calcite saturation waters, associated with a low-Mg calcite shell (Bentov and Erez, 2006; Pettit, 2015). Assemblages showing high simple diversity and abundance of *Elphidium* spp. have been recorded on *Padina pavonica* thalli in the Vulcano waters by Pettit (2015).

The relatively low percentages of phytophilous taxa found in the La Starza show some resemblances with the oligotrophic environment pointed out by Pettit et al. (2013). The authors suggest that the low density of bacteria on the seagrasses at Ischia can be an additional stress factor in middle-low pH waters for calcareous epiphytic foraminifers, due to the limited food supply.

In spite of the acknowledged importance of arenaceous foraminifers in low pH Recent environments, where they tend to replace the calcareous taxa (Dias et al., 2010; Pettit, 2015), in the La Starza succession agglutinated specimens are not present. Their absence in biocoenosis as well as in dead assemblages has been explained in different ways, being attributed to the presence of high concentrations of heavy metals (Stubbies et al., 1996), seep gases such as methane or hydrogen sulfide (Panieri et al., 2014), oil and tar (Dermitzakis and Alafousou, 1987).

The little fossilization potential of arenaceous tests (Fillon and Hunt, 1974; Smith, 1987) can be due to direct oxidization and microbial degradation of organic cements, consequently the loss of the shell is frequent in presence of bioturbation or high temperatures (Goldstein and Barker, 1988; Loeblich and Tappan, 1989; Berkeley et al., 2007). Alternatively, absence of arenaceous specimens has been interpreted as the effect of physical disturbance (Mojtahid et al., 2016; Gandhi et al., 2017), absence of clay minerals and dominance by freshly broken non-clay minerals (Quilty, 2010), influence of warm bottom waters (Lowery et al., 2016). In some cases authors merely stated that no satisfactory explanation can be given (Debenay et al., 2001a). We suggest that the lack of agglutinated foraminifers in the La Starza assemblages may be due to relatively high water temperatures, similar to that presently recorded in the Phlegrean Fields area (Rodolfo-Metalpa et al., 2011), contributing to the destruction of the tests.

Occurrence of deposits yielding only siliceous remains has been interpreted as due to low pH, high pCO_2, low $?_{Calc}$ paleoenvironment, in the vicinity of volcanic hydrothermal emissions. Panieri (2006) reported bottom sediments devoid of foraminiferal tests as the result of an exceptional vent activity in the infralittoral marine zone of Panarea. Pettit (2015) has hypothesized that foraminifers are not present in the Vulcano bottom samples, because of winnowing, the coarse grain size and the “inhospitable nature of the sediments”, consisting of shards of glassy particles derived from volcanic events.

Completely barren samples are present in some parts of the succession. Except few continental levels, marine layers devoid of fossil remains seem indicative of a high level of environmental stress. Absence of spicules, the most abundant siliceous remains at La Starza, can be due to high sensitivity of sponges to high temperature, wide temperature fluctuations (Ellison and Farnsworth, 1992; Pawlik et al., 2007) and to bacteria low density (Krautter, 1998). Both these conditions have been recorded in the Ischia waters (Pettit et al., 2013; Pettit, 2015).

In sum, the varying depositional conditions characterizing the La Starza succession may be compared with some Recent environments under the influence of hydrothermal emissions occurring in the Tyrrhenian Sea, showing a remarkable affinity with the shallow waters of the island of Ischia.

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APPENDIX 1.

Benthic foraminifer and ostracod list of species; * indicates allochthonous species.

List of benthic foraminifer species

Adelosina longirostra (d'Orbigny, 1826)
Ammonia aberdoveyensis Haynes, 1973 lobate form
Ammonia aberdoveyensis Haynes, 1973 rounded form
Ammonia beccarii (Linnaeus, 1758)
Ammonia falsobeccarii (Rouvillois, 1974)
Amphicoryna scalaris (Batsch, 1791)
Asterigerinata adriatica Haake, 1977
Asterigerinata mamilla (Williamsom, 1858)
Asterigerinata mariae Sgarrella, 1990
Astrononion stelligerum (d'Orbigny, 1839)
Aubignyna perlucida (Heron-Allen and Earland, 1913)
Bolivina catanensis Seguenza, 1862
Bolivina cistina Cushman, 1936
Bolivina ? *earlandi* Parr, 1950
Bolivina lowmani Phleger and Parker, 1951
Bolivina pseudoplicata Heron-Allen and Earland, 1930
Bolivina variabilis (Williamson, 1858)
Brizalina aenariensis Costa, 1856
Brizalina difformis (Williamson, 1858)
Brizalina spathulata (Williamson, 1858)
Brizalina striatula Cushman, 1922
Buccella granulata (Di Napoli Alliata, 1952)
Bulimina aculeata d'Orbigny, 1826
Bulimina elongata d'Orbigny, 1846
Bulimina marginata d'Orbigny, 1826
Cancris auricula (Fichtel and Moll, 1798)
Cassidulina carinata Silvestri, 1896
Cassidulina obtusa Williamson, 1858
Cibicides lobatulus (Walker and Jacob, 1798)
Cornuspira involvens (Reuss, 1850)
Discorbinella bertheloti (d'Orbigny, 1839)
Elphidium advenum (Cushman, 1922)
Elphidium articulatum (d´Orbigny, 1839)
Elphidium complanatum var. *tyrrhenianum* Accordi, 1951
Elphidium crispum (Linnaeus, 1758)
Elphidium granosum (d'Orbigny, 1826)
Elphidium incertum (Williamson, 1858)
Elphidium macellum (Fichtel and Moll, 1798)
Elphidium maioricense Colom, 1942
Elphidium poeyanum (d'Orbigny, 1839) DS form
Elphidium poeyanum (d'Orbigny, 1839) FS form
Elphidium pulvereum Todd, 1958
Elphidium punctatum (Terquem, 1878)
Epistominella vitrea Parker, 1953
Evolvocassidulina bradyi (Norman, 1881)
Fissurina ? *laevigata* Reuss, 1850
Fissurina nummiformis (Buchner, 1940)
Fursenkoina subacuta (d'Orbigny, 1852)
Fursenkoina tenuis (Seguenza, 1862)
Gavelinopsis praegeri (Heron-Allen and Earland, 1913)
Glabratella erecta (Sidebottom, 1908)
Glabratella hexacamerata Seiglie and Bermúdez, 1965
Glandulina laevigata (d´Orbigny, 1826)
Globocassidulina subglobosa (Brady, 1881)
Globulina minuta (Roemer, 1838)
Grigelis guttiferus (d'Orbigny, 1846)
Haynesina depressula (Walker and Jacob, 1798)
Haynesina germanica (Ehrenberg, 1840)
Hyalinonetrion clavatum (d'Orbigny, 1846)
Laevidentalina communis (d'Orbigny, 1826)
Lagena semistriata Williamson, 1848
Lagena striata (d'Orbigny, 1839)
Lamarckina scabra (Brady, 1884)
Lenticulina sp.
Marginulina similis d'Orbigny, 1846
Melonis affinis (Reuss, 1851)
Neolenticulina peregrina (Schwager, 1866)
Nonion fabum (Fichtel and Moll, 1798)
Nonion sp.
Nonionella turgida (Williamson, 1858)
Oolina hexagona (Williamson, 1848)
Oolina sp.
Parrellina verriculata (Brady, 1881)
Procerolagena gracilis (Williamson, 1848)
Quinqueloculina parvula Schlumberger, 1894
Quinqueloculina pygmaea Reuss, 1850
Quinqueloculina seminulum (Linnaeus, 1758)
Rectuvigerina phlegeri Le Calvez, 1959
Reussella spinulosa (Reuss, 1850)
Reussoolina laevis (Montagu, 1803)
Robertina traslucens Cushman and Parker, 1936
Rosalina floridana (Cushman, 1922)
Rosalina macropora (Hofker, 1951)
Rosalina obtusa d'Orbigny, 1846
Rotorbis auberii (d'Orbigny, 1839)
Sigmoilinita distorta (Phleger and Parker, 1951)
Stainforthia complanata (Egger, 1893)
Tretomphalus concinnus (Brady, 1884)
Trifarina angulosa (Williamson, 1858)
Triloculina trigonula (Lamarck, 1804)

Valvulineria bradyana (Fornasini, 1900)
Valvulineria sp. 1

List of ostracod species

Acanthocythereis hystrix (Reuss, 1850)
Aurila convexa (Baird, 1850)
Aurila prasina Barbeito-Gonzalez, 1971
Aurila sp.
Callistocythere badia Bonaduce, Ciampo and Masoli, 1976
Callistocythere flavidofusca (Ruggieri, 1950)
Callistocythere littoralis (Müller, 1894)
Callistocythere sp.
**Candona neglecta* Sars, 1887
*Candonidae
Carinocythereis whitei (Baird, 1850)
Cistacythereis (*Hiltermannicythere*) *turbida* (Müller, 1894)
Costa edwardsi (Roemer, 1838)
**Cyclocypris* sp.
**Cypria* sp.
**Cyprideis torosa* (Jones, 1850)
**Cypridopsis* sp.
**Cypris pubera* O.F. Müller, 1776
Cytheretta adriatica Ruggieri, 1952
Cytheretta subradiosa (Roemer, 1838)
Cytheridea neapolitana Kollmann, 1960
Cytherois ? *valkanovi* Klie, 1937
Cytheromorpha nana Bonaduce, Ciampo and Masoli, 1976
"*Elofsonia*" *minima* (Bonaduce, Ciampo and Masoli, 1976)
Eucythere curta Ruggieri, 1975
Eucytherura gibbera Müller, 1894
Eucytherura mistrettai Sissingh, 1972
Hemicytherura defiorei Ruggieri, 1953
Hemicytherura videns (Müller, 1894)
*Heterocypris sp.
Leptocythere macella Ruggieri, 1975
Leptocythere ramosa (Rome, 1942)
Loxoconcha aff. *L. elliptica* Brady, 1868
Loxoconcha gibberosa Terquem, 1878
Loxoconcha ovulata (Costa, 1853)
Loxoconcha ? *rubritincta* Ruggieri, 1964
Loxoconcha sp.
Microcytherura angulosa (Seguenza, 1880)
Microcytherura fulva (Brady and Robertson, 1874)
Microcytherura sp.
**Mixtacandona* sp.
Neonesidea aff. *N. longevaginata* (Müller, 1894)
Palmoconcha turbida (Müller, 1912)
Paracytheridea paulii Dubowsky, 1939
Paracytheridea triquetra (Reuss, 1850)
Pontocypris pellucida Müller, 1894
Pontocythere turbida (Müller, 1894)
Procytherideis retifera Ruggieri, 1978
Procytherideis subspiralis (Brady, Crosskey and Robertson, 1874)
**Pseudocandona sarsi* (Hartwig, 1899)
Pseudocytherura strangulata Ruggieri, 1991
Pseudocytherura sp.
Pseudopsammocythere reniformis (Brady, 1868)
Pterygocythereis coronata (Roemer, 1838)
Pterygocythereis jonesii (Baird, 1850)
Rectobuntonia subulata (Ruggieri, 1954)
Sagmatocythere versicolor (Müller, 1894)
Sagmatocythere sp.
Sahnicythere retroflexa (Klie, 1936)
Semicytherura alifera Ruggieri, 1959
Semicytherura dispar (Müller, 1894)
Semicytherura incongruens (Müller, 1894)
Semicytherura paradoxa (Müller, 1894)
Semicytherura rara (Müller, 1894)
Semicytherura rarecostata Bonaduce, Ciampo and Masoli, 1976
Semicytherura ruggierii (Pucci, 1955)
Semicytherura sulcata (Müller, 1894)
Urocythereis margaritifera (Müller, 1894)
Urocytherideis ilariae Aiello, Barra and Parisi, 2016
Xestoleberis communis G.W. Müller, 1894
Xestoleberis dispar Müller, 1894
Xestoleberis ? *rara* Müller, 1894

Asterisk indicates taxa recognized as allochthonous.